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Psychological Need Satisfaction and Exercise

by

Philip Michael Wilson ©

A thesis submitted to the Faculty of Graduate Studies and Research in partial fulfillment of the requirements for the degree of Doctor of Philosophy.

Faculty of Physical Education and Recreation

Edmonton, Alberta

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Faculty of Graduate Studies and Research

The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research for acceptance, a thesis entitled 'Psychological Need Satisfaction and Exercise' submitted by Philip Michael Wilson in partial fulfillment of the requirements for the degree of Doctor of Philosophy.

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Dedication

This dissertation is dedicated to my family…affectionately known by all who hear me speak often and passionately about them as "Big Norms", My Auld Man, "Smudger", The "King", Grandad Reed, Nana, and not forgetting "Our Bonnie". A notable scientist is reported to have once said: "I see so far because I stand on the shoulders of giants" (Albert Einstein, *year unknown*). While the content and quality of my vision remains my responsibility alone, each and every one of you built the foundation that allows me to see whatever I choose to look at, and for that I am eternally grateful.

Abstract

The purpose of this dissertation was to develop a measure of psychological need satisfaction specific to the context of exercise within the framework of Deci and Ryan's (1985; 2002) Self-Determination Theory (SDT), and to evaluate the relationships between need satisfaction and regulations motivating exercise participation. Study 1 used an open-ended approach to identify both unique and common experiences that promoted feelings of competence, autonomy, and relatedness in exercise, and indicated that the items crafted on the basis of these responses were both relevant and representative of need satisfaction constructs from SDT's perspective. An important finding stemming from study 1 was that relatedness does not appear to be a need required by all exercisers. The final product of study 1 was the Psychological Need Satisfaction in Exercise Scale (PNSE), and 18-item self-report measure of perceived competence, autonomy, relatedness (6 items per construct) that was evaluated in studies 2 and 3. The results of study 2 and 3 supported the internal structure of the PNSE four separate samples that were diverse in their demographic composition. Additional evidence in Study 2 indicated strong support for the convergent and divergent validity of the PNSE subscales and questioned the construct validity of existing measures of psychological need satisfaction. Study 3 employed structural equation modeling (SEM) and change score analyses to investigate the relationship between perceptions of need satisfaction, exercise regulations, and motivational consequences. Overall, the results of this final study indicated that greater perceived need satisfaction was associated with more self-determined exercise regulations, which in turn, predicted more positive behavioural and psychological consequences. Consistent with the results of study 1, the SEM in study 3 indicated that relatedness was not associated with intrinsic regulation when the contributions of autonomy and competence are considered concomitantly. The findings from this

dissertation indicate that the PNSE is a useful instrument for assessing perceived need satisfaction in exercise from the perspective of SDT, and support the beneficial effects resulting from self-determined exercise regulation irrespective of its intrinsic or extrinsic orientation.

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Navigating the graduate school "quagmire" is rarely a solitary adventure. I am no exception to this dictum and wish to give credit to the people who have shaped both my personal life and my professional development that is (hopefully!) evident in this dissertation. The order of appearance is organized neither alphabetically nor "ordinaly" in any way.

I would like to recognise and thank the contributions made by my supervisor, Dr. Wendy M. Rodgers. I would not have completed my degree without her tenacity in pushing me to my limits and beyond, as well as, her compassion and resourcefulness in seeing my through some of my darkest moments. Cheers Boss! I would also like to recognise the contribution of Dr. W. Todd Rogers to my personal and professional development. You inspired a fascination with statistics and measurement in a mathematically challenged Englishman and stretched me in ways I never thought possible. While I was not always intrinsically motivated by the experience, I always (and shall continue to) recognized the value in what you taught me. I can pay you no higher compliment. My appreciation is extended to Drs. Rich M. Ryan, T. Cam Wild, Janice L. Causgrove-Dunn, and Kerry S. Courneya for having the patience and willingness to be involved in this project.

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Introduction

Measurement has been described as "the Achilles' Heel of behavioural research" (Kerlinger, 1979, p. 141). Nowhere is Kerlinger's analogy more apparent than in exercise psychology research investigating perceptions of need satisfaction within the framework of Self-Determination Theory (SDT; Deci & Ryan, 1985; 2002; Ryan 1995). According to SDT, satisfaction of the psychological needs for competence, autonomy, and relatedness are innate and universal tendencies that facilitate motivational development and psychological health (Ryan & Deci, 2001). Although the nature and function of psychological needs remains controversial (Sheldon, 2002; Sheldon, Elliot, Kim, & Kasser, 2001), there is sufficient evidence to suggest that experiences promoting feelings of competence, autonomy, and relatedness facilitate motives that underpin long term behavioural persistence and well-being (Deci & Ryan, 2002). An examination of the exercise psychology research to date reveals that the measurement of need satisfaction has been overshadowed by a focus on the link between different types of exercise motivation and their resultant consequences (Vallerand, 2001; Vallerand & Perreault, 1999). Given that understanding the processes shaping exercise motivation decisions is an important agenda for exercise research, it is surprising that no systematic attempt has been made to measure need satisfaction in exercise from the perspective of SDT.

The overall purpose of this research was to develop and evaluate a measure of psychological need satisfaction designed within the framework of SDT specifically for use in exercise contexts. To accomplish this purpose, the following studies were predicated on SDT's contention that psychological needs for competence, autonomy, and relatedness represent necessary "nutriments" (Deci & Ryan, 2002, p. 7) that are innate, universal, and fundamental conditions for motivational development. Using SDT's propositions as a nomological net (Cronbach & Meehl, 1955), the first study was conducted to (a) identify exercise-specific experiences that facilitate need satisfaction, and (b) create and evaluate a set of candidate items designed to measure perceived competence, autonomy, and relatedness. The objective of study 2 was to examine the psychometric properties of the items developed in study 1 using a construct validation approach to assess both within network (the internal structure of the test) and between network (relationships between the test and external "markers") relationships (Loevinger, 1957; Messick, 1989; 1995). Finally, the central purpose of study 3 was to examine SDT's contentions regarding the role played by psychological need satisfaction during the internalization of exercise motives using the instrument developed via the previous two studies. Marsh (1997) argued that theory and measurement are "inexorably intertwined" (p. 27) such that neglecting one aspect during the process of instrument development will simultaneously undermine the other. Keeping both Marsh and Kerlinger's criticisms in mind, the present research addressed the measurement of psychological need satisfaction in exercise from the perspective of SDT.

Overview of Self-Determination Theory

SDT contains two central propositions that make this theoretical framework particularly appealing for the study of exercise motivation. The first theoretical premise contends that extrinsic motivation is multidimensional, and resides along a regulatory continuum that ranges from being highly controlling to more autonomously endorsed and self-determined in nature. Complimenting this initial argument regarding the nature of human motivation, the second theoretical proposition forwarded by SDT addresses the notion of basic psychological needs for competence, autonomy, and relatedness, and the degree to which their satisfaction in a given domain (or in general) facilitates optimal self-regulation, human development, and motivational expression (Deci & Ryan, 1985; 2002; Ryan, 1995; Shahar, Henrich, Blatt, Ryan, & Little, 2003).

The first proposition concerning the nature of human motivation argues for the presence of a motivational continuum of regulations that makes fine distinctions between amotivation, different forms of extrinsic motivation, and pure intrinsic motivation (Deci & Ryan, 1985; 2002; Ryan & Deci, 2000). At one end of SDT's regulatory continuum is amotivation, a state akin to learned helplessness where the person lacks the intention to engage in a behavior and typically experiences psychological maladjustment (Deci & Ryan, 1985; 2002; Ryan & Deci, 2000). Anchoring the other end of the continuum is intrinsic regulation which concerns participation because the behavior itself is autotelic and inherently enjoyable (Deci & Ryan, 1985; 2002). In direct contrast, people who participate for intrinsic reasons demonstrate an adaptive profile of motivational consequences that includes both prolonged involvement and enhanced psychological health outcomes (Deci & Ryan, 1985; 2002; Ryan & Deci, 2000).

In accordance with theoretical arguments concerning the nature of motivation, Ryan (1995) notes that the "lion's share of social development concerns the assimilation of culturally transmitted behavioral regulations and valuations that are neither spontaneous nor inherently satisfying" (p. 405). On the basis of this argument, a major proposition stemming from SDT is that extrinsic motives are multidimensional in nature and are best represented by a continuum of regulatory processes that range from being highly coercive and controlled through to those more autonomously endorsed or self-determined in nature. The process of internalization reflects a person's relative position along the regulatory continuum, and is primarily concerned with how people transform externally controlled motives into more personally valued and integrated regulations (Deci & Ryan, 2002; Grolnick, Deci & Ryan, 1997; Ryan, 1995).

SDT's graded conceptualization of extrinsic motivation is in stark contrast to other theoretical frameworks that "pit" various motivational orientations against one another in an attempt to understand human development and agency (Roberts, 2001). According to SDT (Deci & Ryan, 1985; 2002; Ryan, 1995; Ryan & Deci, 2000), behavioral engagement is not necessarily motivated for intrinsic reasons and therefore necessitates some extrinsic inducement. However, SDT asserts that distinct regulatory qualities comprise the continuum of extrinsic motives which have a more diversified influence on behavioural and psychological consequences than the generally positive effects that stem from intrinsically regulated participation (Deci & Ryan, 2002; Ryan & Deci, 2000).

External regulation is the most controlling form of extrinsic motivation outlined within SDT, and represents the point along the continuum that most closely approximates traditional conceptualisations of extrinsic motivation (Deci & Ryan, 2002; Ryan & Deci, 2000). People who rely on externally regulated reasons to motivate their behavior resemble "pawns" who permit their actions to be dictated by external inducements (deCharms, 1968; Deci & Ryan, 1985; 2002; Ryan & Deci, 2000). Examples of factors that characterize the notion of external regulation include participation that is geared towards avoiding punishment, threat compliance, obtaining rewards, or conforming to social constraints.

Introjected regulation, the next point along the regulatory continuum, is a less coercive form of extrinsic motivation compared with external regulation but is still considered to be a controlling form of extrinsic motivation (Deci & Ryan, 2002; Ryan & Deci, 2000). Behavior that is motivated through introjected regulations concerns engagement to avoid negative feelings of guilt or shame or to maintain a "contingent" sense of self-worth (Deci & Ryan, 1995). Stated differently, this form of extrinsic motivation concerns the partial internalization of external contingencies into self-imposed intrapsychic pressures to conform behaviourally (Deci & Ryan, 2002; Ryan, 1995; Ryan & Deci, 2000). People who engage in a behavior for predominantly introjected reasons often do so out of a sense of obligation and therefore regulate their behavior according to what they "should" do in a particular situation or context more generally rather than what they "value" or "enjoy" doing per se.

The next point along the motivational continuum is *identified regulation*, which conceptually represents the "lower bound" of self-determined extrinsic motivation, and concerns motives that recognize the personal importance and value associated with the benefits to be derived from the target behavior itself (Deci & Ryan, 2002; Ryan & Deci, 2000). A central distinction between behaviours that are regulated for introjected versus identified reasons is that the latter is emitted out of a sense of choice rather than feelings of reluctant obligation or compliance. Despite this distinction, identified regulations are still considered to be extrinsic motives due to the instrumental nature of behavioural engagement (Deci & Ryan, 2002; Koestner & Loser, 2002; Ryan & Deci, 2000). Notwithstanding this theoretical distinction, participation for identified reasons is considered to be self-determined as the person has internalized the value associated with the activity and engages of their own free volition.

The final form of extrinsic motivation located along SDT's regulatory continuum is labelled integrated regulation, and represents the "upper boundary" of self-determined extrinsic motives (Deci & Ryan, 2002; Ryan & Deci, 2000). *Integrated regulation* also entails engaging in a given set of behaviours through personal choice rather than through coercion. However, the distinction between integrated and identified regulations rests on the extent to which the behavior has been coherently interwoven into the fabric of the self, or in SDT parlance, becomes an integrated portion of the "true self" (Deci & Ryan, 1995). Integrated regulation occurs "when identified regulations have been fully assimilated to the self" (Ryan & Deci, 2000, p. 62), and conceptually represents the final point of internalization along the regulatory continuum of extrinsic motives. People motivated by integrated reasons engage because their involvement in the behavior now represents a coherent component of their personal identity, rather than an act performed to obtain some personally valued outcomes.

The appeal of SDT's motivational continuum is that it facilitates a more refined analysis of the relationship between controlling and self-determined regulations and important consequences such as behavioral engagement, task persistence, and the promotion of psychological well-being (Deci & Ryan, 1985; Ryan, 1995; Ryan & Deci, 2000). Consistent with other perspectives on motivation (Roberts, 2001), SDT contends that intrinsic regulation predicts the most positive motivational consequences in most contexts, and evidence in numerous areas supports this theoretical argument (see Ryan & Deci, 2001 and Vallerand, 2001 for a review). However, Ryan (1995) asserts that when the task itself is not inherently interesting it seems unlikely that persistence behavior will be regulated for intrinsic reasons alone. Consequently, the subtle distinctions made between different forms of extrinsic motivation aligning SDT's regulatory continuum are important for disentangling the types of extrinsic motivation that promote adaptive versus insidious behavioural and psychological consequences. Although a number of issues require further research, the available evidence does suggest that more internalized forms of extrinsic motivation represented by identified and integrated regulations promote positive behavioural and psychological health consequences (Deci & Ryan, 2002). By contrast, less self-determined forms of internalization represented by controlling introjected and external regulations appear to be less adaptive in nature and facilitate adverse motivational outcomes such as short-term involvement and psychological maladies (Koestner & Loser, 2002).

In addition to theoretical arguments concerning the consequences of motivation, SDT also includes propositions regarding the conditions facilitating and sustaining motives that span the regulatory continuum (Deci & Ryan, 1985; 2002; Ryan, 1995; Ryan & LaGuardia, 2000). According to SDT, the satisfaction of three basic psychological needs for *competence*, *autonomy*, and *relatedness* represent essential innate and universal components of optimal self-regulation and psychological growth (Deci & Ryan; 2002; Ryan, 1995; Ryan & Deci, 2000). According to SDT, these basic psychological needs represent essential "nutriments" (Ryan, 1995, p. 399) that promote internalization and integrative tendencies. From a conceptual perspective, the basic psychological needs for competence, autonomy, and relatedness are distinguishable from personal desires (or "wants") given that the former are essential to human functioning whereas the latter remain superfluous (Deci & Ryan, 2002; Ryan, 1995).

The need for *competence* stems from seminal work of White (1959) who coined the term "effectance motivation" to describe the innate desire to engage in and master personally challenging tasks efficiently and effectively. The need for *autonomy* originates from the work of deCharms (1968) and refers to a personal desire to feel like one is the "agent" and not the "pawn" in their behaviour endeavours. Stated differently, the need for autonomy concerns a person's desire to act in accordance with their values and to be the origin (or self-initiator) of his/her participation in a given behaviour rather than have their involvement coerced by seductive forces alien to the self (Deci & Ryan, 1995; Ryan, 1993; 1995). In conjunction with the needs for competence and autonomy, SDT also asserts that the need for relatedness is central to the process of internalization and the assimilation of values and norms that have external origins (Deci & Ryan, 2002). The need for *relatedness* (which is conceptually similar to "belongingness"; Baumeister & Leary, 1993) recognizes the central importance played by social agents in the internalization process and acknowledges that people have this innate desire to feel meaningfully connected to others in their social milieu.

The appeal of SDT's conceptualization of psychological needs as nutrients of a functional "self" is an understanding of the conditions required for successful internalization of external contingencies into more self-determined regulations (Deci & Ryan, 2002). The importance of need satisfying experiences to human development is underscored by Ryan and LaGuardia (2000) who assert that "when any of these three basic psychological needs is frustrated or neglected in a specific form or in general, individuals will show motivational and psychological decrements of a specifiable nature, including diminished vitality, volition, integration, and well being" (p. 150). Recent research by Sheldon and colleagues corroborates Ryan and LaGaurdia's arguments given that need satisfaction in a specific context (i.e., education) has been associated with more self-determined motives for goal striving (Sheldon & Elliot, 1999, study 3) and positive psychological health outcomes (Sheldon & Elliot, 1999, study 2; Sheldon, Elliot, Kim, & Kasser, 2001).

SDT and Exercise

Given that SDT makes specific arguments concerning the consequences ensuing from different types of motivation, it is hardly surprising that research efforts in exercise psychology have focused predominantly on SDT's regulatory continuum (Mullan, Markland, & Ingledew, 1997; Mullan & Markland, 1997; Wilson et al., 2002a). One line of research that reflects this focus has concerned itself with the development and evaluation of instruments designed to capture SDT's graded continuum of exercise motives (Li, 1999; Mullan et al., 1997; Wilson, Rodgers, & Fraser, 2002a; 2002b). A second line of research reflecting this focus is applied in nature, and has examined the relationship between the regulatory continuum of motives and relevant consequences of interest such as frequency of exercise participation and psychological health indicators (Kowal & Fortier, 2000; Mullan & Markand, 1997; Wilson & Rodgers, 2002). Overall, these approaches enhance our understanding of the motivational processes influencing exercise participation decisions, a particularly important research agenda given the prevalence of sedentary lifestyles and pervasiveness of discontinuation within the first 6 months of initiating exercise involvement (Dishman, 1994; Sallis & Owen, 1999; United States Department of Health & Human

Services, 1996). Despite the appeal of these applications of SDT, the dominant focus on the motivation-consequence link has overshadowed the contributions made by psychological need satisfaction to motivational processes in the exercise context.

Given the regulatory continuum is a major theoretical proposition within SDT, initial empirical work in exercise contexts has focused on developing instruments to capture the relevant points along the continuum (Mullan et al., 1997; Li, 1999). Building upon Frederick's early work (Frederick & Ryan, 1993; Ryan, Frederick, Lupes, Rubio, & Sheldon, 1997) Mullan and colleagues (Mullan et al., 1997; Mullan & Markland, 1997) developed the only measure of exercise motivation based strictly on SDT's conceptualization of the regulatory continuum. The Behavioural Regulation in Exercise Questionnaire (BREQ; Mullan et al., 1997) was derived on the basis of responses drawn from community sports centre attendees in the United Kingdom ($M_{age} = 29.98$; $SD = 9.18$; 68% female). In their original development and validation article, Mullan et al. (1997) employed confirmatory factor analytic procedures to develop and support the presence of a 4-factor measurement model that was consistent with the overall framework of SDT, partially invariant across gender, and contained subscales that demonstrated a simplex pattern of relationships supporting the presence of a regulatory continuum. A simplex pattern of relationships (Guttman, 1954) holds that distal points along the motivational continuum should be less positively associated with one another than proximal points. Subsequent research has further corroborated the multidimensional oblique measurement model by supporting the simplex pattern of subscale relationships associated with the BREQ (Wilson et al., 2002a) and linking scores on the identified and intrinsic regulation subscales of the BREQ with more autonomously oriented personalities (Rose, Markland & Parfitt, 2001). The available evidence suggests that the BREQ has some psychometric credibility and holds considerable appeal for addressing motivational issues from the perspective of SDT in the exercise domain.

Outcomes of Exercise Regulations

Following the development of the BREQ, a number of studies have sought to use the scale (or proxy motivational measures such as the Exercise Motivation Inventory; Markland & Hardy, 1993) to address the theoretical argument that more self-determined or internalized forms of motivation promote adaptive behavioural and psychological consequences in exercise contexts. A large body of literature supports the positive association of intrinsic regulation with positive motivational consequences such as time invested in exercise behavior (Orlick & Mosher, 1978), enjoyment (Brustad, 1988), exercise participation (Losier et al., 1993; Robertson & Mutrie, 1989; Ryan et al., 1997), changes in readiness to undertake exercise from thinking about participating to actual behavioural engagement (Ingledew, Markland, & Medley, 1998), and elevated levels of physical self-esteem (Wilson & Rodgers, 2002).

Although SDT asserts that intrinsic regulation of behavior will be associated with positive motivational consequences, the theory makes more refined arguments pertaining to the beneficial effects of stemming from self-determined forms of extrinsic motivation. Ryan (1995) has noted that in some domains more self-determined forms of extrinsic motivation that reflect a higher degree of internalization might be important in promoting positive behavioural patterns and psychological health given that it is unlikely that the behavior itself will stimulate intrinsic interest. Although few studies have addressed Ryan's contention directly in exercise contexts, a growing body of research reports that identified regulation is a stronger correlate and predictor of behavioural indices in exercise contexts than intrinsic regulation (Wilson et al., 2002a; Wilson & Rodgers, in press). On the basis of the current evidence, it does appear that intrinsic regulation and more self-determined forms of extrinsic motivation (namely identified regulation) are more favourably associated with behavioural participation and indices of psychological health compared to controlling forms of behavioural regulation.

Limitations of Previous Exercise-Based Research Examining Psychological Need Satisfaction

Despite the generally positive findings generated from exercise-based research examining SDT's propositions, a number of theoretical and applied issues require more careful examination. Perhaps the most pressing issue for advancing this line of applied SDT research is a careful examination of the role played by psychological need satisfaction in exercise motivation given that perceived competence, autonomy, and relatedness play a prominent theoretical role in human agency (Ryan & Deci, 2000). An examination of the current exercise literature indicates that there is no acceptable measure that captures each need satisfying experience in a manner consistent with SDT's propositions.

Current attempts to measure perceptions of need satisfaction have focused almost exclusively on the notion of perceived competence as it relates to exercise participation (Vallerand & Perreault, 1999). This is hardly surprising given that the majority of theoretical frameworks employed to study exercise motivation issues to date include constructs that are analogous with, or conceptually similar to, perceived competence in their theoretical frameworks (Bandura, 1997; Prochaska & DiClemente, 1983). Although this research examines a selection of the motivational processes operating in exercise contexts, self-determination theorists advocate that autonomy and relatedness needs might also be important in internalizing regulatory processes. It therefore seems reasonable to assert that the major deficit in the exercise literature as it presently stands concerns the measurement of perceived autonomy and relatedness from the perspective of SDT.

Perceived Autonomy. Despite the restrictively narrow focus of previous exercise research, some recent attempts have been made to assess perceived autonomy in exercise contexts. Most notably, Markland and colleagues (Markland & Hardy, 1997; Markland, 1999; Rose et al., 2001) developed the Locus of Causality for Exercise Scale (LOCE) in response to criticisms of the perceived choice subscale associated with the Intrinsic Motivation Inventory (IMI; Ryan, 1982). Markland and Hardy developed the LOCE as a measure of how "agentic" people feel relative to being the source that initiates their exercise behavior rather than being controlled by various external contingencies. Markland and Hardy (1997) developed the 3-item LOCE through a series of exploratory and confirmatory factor analyses on an initial pool of nine items that were written and developed solely on the basis of Deci and Ryan's (1985) depiction of the perceived locus of causality construct. Initial studies using the LOCE provide preliminary support for the factor structure and internal consistency reliability of the instrument in female exercise participants, and indicate scores on the LOCE correlate with intrinsic motivation in a manner consistent with theoretical expectations (Markland & Hardy, 1997; Markland, 1999).

Although the LOCE appears to be somewhat promising, recent work by Reeve (2002) suggests that the notion of perceived autonomy (albeit in the educational sphere) comprises at least "three essential qualities" (p. 197). These qualities were labelled as an *internal perceived locus of causality* (a person's belief that they are responsible for the initiation and regulation of their own behavior), a *sense of volition* (a degree of willingness to engage in a behavior that is pressure free), and a *perception of choice* (having some degree of flexibility in terms of decision-making opportunities pertaining to behavioural regulation). Although it might seem unjust to criticize the LOCE on the basis of research conducted after the scale was developed, it does seem reasonable to suggest that the item-content of the LOCE does not fully represent perceived autonomy in a manner consistent with SDT (Deci & Ryan, 1985; 2002).

Given the lack of an established measure of perceived autonomy in exercise contexts, and in light of the LOCE's conceptual deficiency, subsequent research has employed alternative instruments in an attempt to capture perceptions of autonomy in exercise contexts. During the development of the Exercise Motivation Inventory (EMI), Li (1999) used a modified version of the Internality subscale drawn from the Exercise Objectives Locus of Control Scale (EOLOC; McCready & Long, 1985) to assess perceptions of autonomy drawn from exercise settings. The Internality subscale of the EOLOC was developed on the basis of Social Learning Theory (Rotter, 1964) to assess the degree to which a person feels that the reinforcements they receive from the behavior are attributable to their own actions as opposed to either those of powerful others or simply to chance occurrences (McCready & Long, 1985). Although the EOLOC's Internality subscale has demonstrated some credible psychometric properties (Li, 1999; McCready & Long, 1985), the scale suffers from the same conceptual shortcoming as the LOCE given that it represents only a portion of the experiences that contribute towards feeling autonomous (Reeve, 2002). On the basis of this conceptual quandary, the EOLOC is limited in terms of covering the breadth of perceived autonomy in exercise contexts from an SDT perspective.

Aside from the LOCE and the EOLOC, two other measures of perceived autonomy have been used in applications of SDT to exercise. In a series of studies examining the motivational determinants of flow, Kowal and Fortier (1999; 2000) adapted items from the unpublished Autonomy Perceptions in Life Contexts Scale (APLCS; Blais & Vallerand, 1992) to assess perceived autonomy surrounding exercise behavior in master's level swimmers. Although the APLCS appeared promising, the available evidence is less convincing given that (a) the full array of APLCS items used by Kowal and Fortier (1999;

2000) remains undisclosed and therefore it is difficult to determine the degree to which the APLCS fully represents the construct of perceived autonomy, and (b) the low internal consistency reliability coefficients (Cronbach's Coefficient $\alpha < .60$; Kowal & Fortier, 1999; 2000) question the utility of the adapted APLCS items in the context of exercise. Furthermore, the original development of the APLCS appears to be in French rather than English (which was part of the modifications implemented by Kowal & Fortier in both studies) necessitating consideration of the potential for translation difficulties. Given the origin and available data pertaining to the APLCS, it appears that the scale fails to circumvent the content-representation problems inherent in the LOCE and the EOLOC, and is therefore likely inadequate as a measure of perceived autonomy in applications of SDT to the study of exercise motivation.

The second set of instruments used to measure perceived autonomy in applications of SDT to exercise comes from research by Wilson and colleagues. An initial study used an adapted version of the Activity Feeling Scale (AFS; Reeve & Sickenius, 1993) to address perceptions of competence, autonomy, and relatedness in exercise contexts and how these perceptions relate to motives spanning SDT's regulatory continuum (Wilson, Rodgers, Blanchard, & Gessell, in press a). The AFS was developed specifically for the purposes of examining theoretical hypotheses surrounding need satisfaction. Despite the appeal of the AFS's origins, the results of a study reported by Wilson et al. (in press a) indicated that an item ("participation in exercise makes me feel offered a choice of what to do") had to be removed from the AFS-Autonomy subscale due to the low item-total (*r*'s < .35) correlations. Although the reliability estimate of the AFS-Autonomy subscale improved considerably (α's = .74 and 68 respectively at two time points), the removal of items does raise questions pertaining to the suitability of the modified AFS-Autonomy subscale for use in subsequent exercise research. On the basis of the available evidence, the AFS-Autonomy subscale cannot be recommended as a suitable instrument for exercise research interested in examining SDT's notion of perceived autonomy.

Given the concerns surrounding the aforementioned instruments, subsequent studies adapted single-item measures for each need satisfaction construct for the purposes of testing relationships between perceived need satisfaction and a continuum of exercise regulations (Wilson et al, 2002a; 2002b). Drawing from Sheldon's model of self-concordance (Sheldon, 2002), Wilson and colleagues modified three questions to represent perceptions of need satisfaction for competence, autonomy, and relatedness in the exercise domain (Wilson, Rodgers, & Fraser, 2002a; 2002b). Although the single item used to capture perceived autonomy in the exercise (i.e. "I typically feel autonomous and choiceful in the exercises that I do") was positively associated with more self-determined exercise regulations in a manner specified by SDT (Deci & Ryan, 1985; 2002), the use of single-item indictors is not without potential shortcomings. Despite the theoretical appeal and empirical support of this single item index of perceived autonomy, the use of single-item indicators of psychological constructs is generally not recommended from a psychometric perspective. Such an approach is unlikely to fully represent the construct of perceived autonomy in exercise (Crocker & Algina, 1986; McDonald, 1999), and therefore, considerable scope for further investigation of perceived autonomy in exercise contexts seems apparent.

Perceived Relatedness. Consistent with the research examining perceived autonomy in exercise, a few isolated studies have used either a proxy instrument or modified an existing measure in an attempt to capture the notion of perceived relatedness in exercise contexts. Li (1999) employed Harter's (1985) Social Support scale as an index of perceived relatedness in his EMS studies. Although there is a conceptual link between feeling related and being socially supported (Ryan & Solky, 1996), the use of Harter's scale as a measure of perceived relatedness is problematic in at least two ways. First, the scale was originally developed for use with children with no established psychometric evidence to support the scale's utility in the adult samples that Li (1999) examined in his instrument development research. Second, it seems reasonable to suggest that one could feel socially supported through the quantity of networked relationships in operation with other people and yet not feel meaningfully connected or "related" within one's social milieu. Psychometricians have repeatedly warned against using instruments outside of the populations they were intended for, as well as, called into question the utility of using the same instrument to measure conceptually similar yet distinct psychological constructs (a practice that has been labelled the "jingle-jangle" fallacy; Marsh, 1994).

Considering the psychometric concerns associated with Li's (1999) measure of perceived relatedness, subsequent research by Wilson and colleagues used a modified version of the AFS (Wilson et al., in press a), as well as, a single item indicator drawn from Sheldon's (2002) research on self-concordance to quantify perceived relatedness in exercise. In their research examining the psychometric properties of motivational instruments, Wilson et al. (2002a; 2002b) used a single item ("I feel related and connected to the people I exercise with") measure of perceived relatedness in exercise contexts. Despite the finding that this item was more positively correlated with self-determined forms of exercise regulation (Wilson et al., 2002a; 2002b), the weak relationships reported in these studies was attributed to a lack of full content representation evident in the measurement of perceived relatedness adopted in these studies. Consequently, a second study used an adapted version of the Relatedness subscale drawn from the AFS (AFS-R; Reeve & Sickenius, 1993). While the AFS-R does contain multiple items, the subscale demonstrated relationships with exercise regulations, motivational consequences, and perceived competence and autonomy (also measured with the AFS) that were contradictory to SDT's propositions. One explanation for this finding is the lack of relevance evident in the item content of the AFS-R for exercise contexts (Fitzpatrick, 1983). For example, one of the AFS-R items asked participants if exercise makes them feel "brotherly or sisterly". Collectively, it seems that neither the single item index nor the AFS-R adequately measures perceived relatedness in exercise in accordance with SDT.

A final measure of perceived relatedness was employed by Kowal and Fortier (1999; 2000) who modified the Perceived Relatedness Scale (PRS; Richer & Vallerand, 1996) to assess the degree to which people felt a sense of belonging to other members of their swim team during exercise sessions. The modified version of the PRS contains three self-report items that were adapted from a scale designed to measure how meaningfully connected one generally feels to others in life (Richer & Vallerand, 1996). Although the limited psychometric characteristics reported by Kowal and Fortier (1999; 2000) attest to the internal consistency reliability of the scale items, a closer inspection of the item content raises questions pertaining to the suitability of the modified PRS. Consistent with the conceptual criticism applied to Li's (1999) EMS research, one of the items used by Kowal and Fortier (1999; 2000) read as follows: "During this practice, in my relations with the members of my current swim team, I felt *support*" (emphasis added). As previously discussed in relation to the use of Harter's (1985) scale, the notion of support is conceptually linked with perceived relatedness to some degree. However, it is the quality of the social experience that matters most in terms of enhancing feelings of relatedness from an SDT standpoint, not merely whether one feels supported or not.

In addition to the conceptual concerns regarding the item content of the modified PRS (Kowal & Fortier, 1999; 2000), additional concerns exist pertaining to the validity of the scores derived form the instrument. Psychological need satisfaction is a fundamental proposition of SDT that contends support for each psychological need should be associated with support for the other needs suggesting that there should be a pattern of positive relationships evident amongst need satisfaction measures (Deci & Ryan, 2002; Ryan, 1995; Sheldon, Elliot, Kim & Kasser, 2001). An inspection of the interscale relationships reported by Kowal and Fortier (2000) indicates that perceptions of relatedness were not associated (*r*'s < .04) with perceived autonomy irrespective of the level of analysis considered (Kowal & Fortier, 2000). Aside from the conceptual ambiguity associated with one of the modified PRS items, the original PRS was not developed to measure need satisfying experiences specifically in exercise contexts, and the modified PRS proposed by Kowal and Fortier (1999; 2000) was not subjected to a thorough psychometric examination in their research on motivational determinants of flow experiences in swimmers. Therefore, it does seem reasonable to suggest that there is considerable scope for further empirical investigation into the measurement of perceived relatedness in the exercise context from the perspective of SDT.

Summary and Overview of Current Research

Given the appeal of SDT for understanding the regulatory processes responsible for promoting participation behaviours and motivational development in exercise contexts, it is surprising that no systematic attempt has been made to measure perceived need satisfaction in exercise psychology research to date. Previous research conducted strictly from the perspective of SDT in the exercise domain suggests that the theory holds considerable appeal for understanding motivational influences and processes (Li, 1999; Mullan et al., 1997; Mullan & Markland, 1997; Wilson & Rodgers, 2002). It therefore seems prudent to suggest that an important future research direction would be the development of a measure of perceived psychological need satisfaction specific to the context of exercise.

Such an endeavour would seem important for advancing our understanding of motivational processes in exercise from the perspective of SDT for a number of reasons.

First, it seems clear from the foregoing discussion of the measurement of psychological need satisfaction in exercise research that insufficient attention has been afforded these constructs from a theoretical and psychometric perspective in comparison to the measurement development attempts addressing SDT's regulatory continuum (Deci & Ryan, 1985; 2002). Second, the absence of a suitable measure of psychological need satisfaction has prevented a more sophisticated examination into the relationships between need satisfying experiences and exercise regulations that span the motivational continuum. Perhaps more importantly, the lack of a suitable measure of perceived need satisfaction calls into questions to veracity of previous exercise-based research into need satisfaction. On the basis of these observations, a systematic attempt to assess perceived psychological need satisfaction in exercise from the vantage point of SDT is warranted if applied exercise research is to use this theoretical framework effectively. Such a venture would seem particularly timely and prudent given that the specific experiences that promote need satisfaction vary as a function of the context in which the behavior is emitted (Deci & Ryan, 2002).

Considering the shortcomings of previous instruments employed in exercise-based studies, the research conducted in this investigation was designed with two overall objectives in mind. The first objective was to develop a measure of perceived psychological need satisfaction specifically for use in applications of SDT in exercise contexts using a construct validation approach to instrument development (Loevinger, 1957; Marsh, 1997; Messick, 1989; 1995). Toward this end, two studies were designed with the intent of generating and evaluating a set of items that were relevant to need satisfying experiences derived from exercise and representative of each psychological need satisfaction construct in the context of exercise as they have been defined by SDT (Deci & Ryan, 1985; 2002). The first study sought input from different "expert" sources in two phases using a mixed-method approach to develop and evaluate a preliminary initial set of psychological need satisfaction items. On the basis of the items derived from study 1, data were gathered in two phases comprising study 2 to examine both the within and between network relationships exhibited by scores on the newly formed instrument.

The second overall objective of the present investigation was to examine the relationship between need satisfying experiences for competence, autonomy, and relatedness and the full array of exercise regulations outlined within the framework of SDT (Deci & Ryan, 1985; 2002). This objective was considered important given that previous research has examined only one form of motivation (typically focusing on intrinsic regulation only at the expense of a differentiated assessment of extrinsic motivation), or amalgamated the points along the regulatory continuum into a single motivational index (labelled the Relative Autonomy Index [RAI]; Ryan & Connell, 1989). Recent commentary (Koestner & Losier, 2002) and research (Shahar et al., 2003; Wilson, Rodgers, Fraser, & Murray, in press b) have questioned the utility of using the RAI in applications of SDT given that this approach masks the "important distinctions concerning the relative contribution of each type of motivation" (Koestner & Losier, 2002, p. 118) to the issue under study. Given the importance of understanding the conditions that foster different exercise motives, data were collected in separate phases across study 3 to address the relationship between satisfaction of competence, autonomy, and relatedness needs in exercise and motives that reside along SDT's regulatory continuum.

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Study 1

Item Generation and Content Validity

The purposes of this study were twofold and were addressed in two sequential phases. The purpose of phase 1 was to explore the types of experiences within exercise contexts that contribute toward feeling competent, autonomous, and related. Data for this first phase were collected from participants enrolled in structured exercise classes using a series of open-ended questions designed to probe experiential accounts of need satisfaction in exercise. The purpose of phase 2 of this study was to empirically evaluate the content relevance and representation of an initial set of items designed to measure psychological need satisfaction in exercise contexts in line with the propositions of SDT (Deci & Ryan, 1985; 2002; Ryan, 1995). The initial set of items was developed on the basis of data collected from responses to the open-ended questions posed in phase 1 of this study. To address the purpose of the second phase in this study, data were collected from a sample of expert judges using procedures advocated in both the scale construction and psychometric literatures (Crocker & Algina, 1986; Dunn, Bouffard, & Rogers, 1999; Fitzpatrick, 1983). The final item set comprising the Psychological Need Satisfaction in Exercise Scale (PNSE) was based on modifications resulting from the expert review process.

The following steps were taken to address the purposes of this study. In phase 1, experts reviewed and approved modified definitions for perceived competence, autonomy, and relatedness prior to examining participant experiences with need satisfaction in exercise. Second, the modified definitions and two probing questions were presented to current exercise class participants who provided illustrative examples of experiences that satisfy competence, autonomy, and relatedness needs in exercise. These open-ended responses were content analyzed to determine the nature of the experiences that contribute towards need satisfaction in exercise contexts, and were used as the basis for item generation at the end of phase 1. In phase 2, a panel of experts were selected to determine the degree of content relevance and representation inherent in the initial set of PNSE items developed in phase 1. On the basis of the feedback obtained through the expert review process, the initial set of items was revised to form the final version of the PNSE.

Phase 1

The major purpose of this phase was to explore the types of experiences that contribute toward promoting feelings of competence, autonomy, and relatedness in exercise contexts. No *a priori* hypotheses were formulated for this phase of study 1. It was, however, assumed that satisfaction for each of these psychological needs is innate and universal such that exercise class participants would be able to provide illustrative accounts of their personal experiences that contributed toward, or detracted from, feelings of competence, autonomy, and relatedness. To accomplish this purpose, a series of open-ended questions were posed to current exercise-class participants regarding the specific types of experiences that facilitate feelings of competence, autonomy, and relatedness in exercise contexts.

Method

Participants

A total of 329 participants drawn from 19 university-based exercise classes provided data for this phase of study 1. At the time of data collection, all participants were in the second week of a 12-week exercise class offered during the winter session at a large urban university located in Western Canada. Each exercise class was led by a certified fitness instructor, lasted between 30 and 55 minutes in duration, and focused predominantly on cardiovascular conditioning.

Measures

Demographics. Participants provided self-reported height and weight as well as age and gender for the purposes of describing the sample in the present study (see Appendix A for the all of the instruments used in studies 1 through 3). Participants also completed a modified version of the Godin Leisure Time Exercise Questionnaire (GLTEQ; Godin & Shepherd, 1985). The modified GLTEQ is comprised of 3 self-report items assessing the frequency of mild, moderate, and strenuous exercise done for at least 20 min per session during a typical week. A total exercise score can be calculated by weighting, then summing, each frequency dimension by its associated MET value (a unit representing the metabolic equivalent of physical activity in multiples of resting oxygen consumption) using the following equation: ([strenuous x 9] + [moderate x 5] + [mild x 3]). Previous research has demonstrated that the GLTEQ is easy to understand, responsive to changes in exercise behavior, and demonstrates anticipated relationships with scores derived from physical activity monitors and maximal fitness tests (Cardinal, 1996; Jacobs, Ainsworth, Hartman, & Leon, 1993). Each individual item was weighted by the relevant MET value and then summed to form a composite exercise behavior score (METS) for use in subsequent analyses.

Open-Ended Questions. Two probing questions were devised for each psychological need satisfaction construct to provide insight into the type of experiences in exercise responsible for the satisfaction of competence, autonomy, and relatedness needs. Participants were presented a definition of exercise developed for this study based on current health promotion guidelines (Craig, Russell, Cameron, & Beaulieu, 1999; Pollock et al., 1999; US Department of Health & Human Services, 1996), previous definitions of exercise (Koplan, Casperson, & Powell, 1985), and input from experts with experience in physical activity and health promotion research (K. Fox, personal communication, October 20th, 2000). The definition was used to provide some context for the probing questions eliciting need satisfying experiences and read as follows:

> "*Exercise refers to planned, structured, bodily movements done with the intention of maintaining or improving health, physical fitness, or weight management*".

Participants were then presented with the modified definitions for each psychological need satisfaction construct (see Table 1-1 for the modified definitions) and the following two questions: (1) Think about a time when you felt competent/autonomous/related during an exercise session. Describe in your own words what specifically made you feel this way? and (2) What specific changes would make you feel more or less competent/autonomous/related during an exercise session?

Procedures

The modified definitions used in conjunction with the open-ended probes were developed using the following process. First, the constitutive definitions for competence, autonomy, and relatedness were modified to make them understandable to the target population. These definitions were subsequently sent to one theoretical expert (E. Deci, personal communication, October 13th, 2000) and two exercise psychology experts to determine their comprehensibility and conformity with SDT's conception of psychological needs. All the experts held doctoral degrees in either psychology or physical education/kinesiology, were employed at the associate or full professor level in North American universities, and had an established record of research in motivation evidenced by their publication record in international journals. Each expert was contacted via e-mail and indicated that the alterations made to the psychological need satisfaction definitions were congruent with SDT's conceptualisation of psychological needs. This preliminary step was considered important given that considerable debate exists pertaining to the conceptualization of psychological needs (Sheldon, 2002), and little attempt has been directed at the types of experiences that contribute towards need satisfaction from an SDT standpoint in exercise

(Frederick-Recascino, 2002; Kowal & Fortier, 1999; Vallerand & Losier, 1999; Wilson et al., 2002a; 2002b).

Data Collection

Participants were approached at the end of a regularly scheduled exercise class and invited to participate in a study of personal thoughts and feelings about different exercise experiences. An explanation was provided to each class pertaining to the nature of the study and the manner in which the data were to be collected in an attempt to reduce response bias associated with data collection and instrument administration (see Appendix B for the content of the statement read during each test administration in studies 1 through 3). Following the explanation, participants were given the opportunity to ask questions pertaining to their involvement and the nature of the study prior to providing their consent. The participants took approximately 10 minutes to complete the survey packet in groups varying in overall size and composition (exercise class sizes were not consistent and ranged from 15 to 45 across the 19 classes). All participants completed the demographic section of the questionnaire first followed by the open-ended questions. The presentation of the open-ended questions was randomized during the data collection phase of this study in an attempt to reduce potential order effects associated with the presentation format of the questions embedded within the survey.

Data Analyses

Data analyses proceeded in a series of steps for both the demographic and open-ended questions. First, the numerical data derived from the demographic section of the questionnaire was entered and analyzed using SPSS (version 11.0 for windows). Second, the demographic data were screened for missing values and extreme responses prior to calculating the descriptive statistics. Third, the open-ended responses were transcribed verbatim and read over thoroughly to familiarize the researcher with the content of the responses. Fourth, raw data themes were extracted from the transcribed text in the form of phrases, quotations, key words-in-context, or in some cases smaller sentences that represented examples of experiences that contribute towards feelings of competence, autonomy, and relatedness in exercise contexts. At this stage, these extracted pieces of transcribed text were considered to be the smallest meaningful units of data upon which the remainder of the analysis would be conducted (Miles & Huberman, 1994; Ryan & Bernard, 2000). Fifth, the units of analysis were inspected and those expressing a similar meaning were grouped together to form relevant lower-order themes representing each psychological need satisfaction construct. No further analysis was conducted after this stage given that the next level of abstraction was comprised of the dimensions of psychological need satisfaction drawn from SDT (namely perceived competence, autonomy, and relatedness) that formed the basis for the initial open-ended questions.

Results

Preliminary Data Screening

An inspection of the data indicated that less than 5% of the values for age, height, and weight respectively were missing from the participants' responses. Given the small amount of missing data evident in the study, the mean imputation procedures recommended by Tabachnick and Fidell (2001) were used to replace the missing demographic data. No particular areas of concern appeared evident in terms of the distributional characteristics of any demographic variable following replacement (skewness values ranged from .038 to 1.18 and kurtosis values ranged from -.077 to .792 respectively).

Demographic Characteristics of the Sample

The sample for this study was predominantly female (91.6%), and is comparable to previous research conducted in university-based exercise classes (Wilson et al., 2002a; 2002b). Participants were predominantly young (79.9% of the sample were aged between 18 and 25 years at the time of data collection and ranged from 18 to 35 years of age). Self-reported anthropometric and physical activity data revealed that participants were quite healthy at the time of data collection. Body Mass Index (BMI) values ($M = 22.60$ Kg/M^2; $SD = 2.99$ Kg/M^2) fell within the healthy range for this age cohort (81.3% of this sample fell between the "healthy" range of 18.0 to 24.99 Kg/M^2; American College of Sports Medicine, 1995). Also, participants indicated engaging in physical activity ($M_{mets} = 46.62$; $SD = 17.78$) on a weekly basis at a level comparable with previous research using college-aged samples (Hayes, Crocker, & Kowalski, 1999) and the GLTEQ (Godin & Shepherd, 1985). Consistent with the exercise categorizations used by Rodgers and Gauvin (1998), the majority of participants in this study (55.6 %) would be considered frequent exercisers based on their self-reported participation in three or more sessions of strenuous exercise per week.

Content Analysis

The content analysis procedures applied to the 43 pages of transcribed text produced from the open-ended questions resulted in total of nine lower order themes (see Table 1-2) underpinning the three higher-order dimensions of psychological need satisfaction posited within SDT (Deci & Ryan, 1985; 2002; Ryan, 1995). The higher-order dimensions reflect the structured questions posed during the data collection process. The lower-order categories represent the most inductive form of the data analysis process beyond the transcribed text, and therefore, provide the closest approximation to the comments provided by the participants during this study. Although content coding schemes were desired for each response, an inspection of the transcribed data indicated that 56.4%, 58.5%, and 86% of the competence, autonomy, and relatedness responses could be coded. Data that was not coded were excluded from further analysis. The major reason for not being able to code a piece of data was lack of theoretical relevance to the target construct evident in the transcribed participant response. Examples of responses that lacked theoretical relevance included the following:

> "I'm here to burn fat" (Participant #22's response for first relatedness probe).
>
> "Silliness with the balls is very relating" (Participant #99's response for second relatedness probe).
>
> "It's good now" (Participant #5's response for first competence probe)
>
> "Better spacing of meals/more nutrition" (Participant #163's response for first competence probe)
>
> "My imagination, exciting things happening in my life, music, etc" (Participant #126's response for first autonomy probe)
>
> "My physical change" (Participant #6's response for second autonomy probe)

The following subsections provide a brief discussion of the types of experiences that satisfy competence, autonomy, and relatedness needs in exercise contexts.

Perceived Competence. SDT's conceptualization of perceived competence stems from White's (1959) seminal writings on "effectance" motivation. According to White, people are driven by a need to feel competent or effective in mastering challenging aspects of their environments, and in doing so successfully obtain a "feeling of efficacy" (p. 329) that is intrinsically satisfying. To be included in this category, participants had to mention or describe an experience that indicated they were confident and capable in terms of doing physical exercises that presented some form of challenge to them.

The content analysis procedures applied to the raw data yielded two lower order themes that were thought to reflect experiential aspects of perceived competence in exercise contexts. As shown in Table 1-2, the first theme under perceived competence comprised 12.7% of the coded responses and reflected an interplay between the technical skills or fitness capacities held by the individual and the demands of a specific exercise or the overall exercise session required of the person. The following quotations exemplify this lower order dimension of perceived competence:

> "That the challenge of the class equals my ability level. So I am not becoming bored by monotony or frustrated by difficult moves" (participant #208).
>
> "Able to follow the moves. Not too easy but somewhat challenging" (participant #217).
>
> "I feel competent when I get a tough set that was challenging this way. I feel competent because it was something hard/difficult that I was able to get" (participant #263)
>
> "Being matched to the correct level of exercise" (participant #98).

The second theme underlying perceived competence in exercise contexts is "personal appraisal of one's abilities", a lower-order theme comprised of 43.6% of the coded responses. The central issue characterizing this lower order theme is a sense of personal confidence in being able to successfully complete a given exercise or execute the required movements. The following quotations represent examples of the participant responses defining this lower-order theme:

> "I was able to do the exercise pattern without messing up" (participant #61).
>
> "The fact that I could do what was required and I knew I could do it" (participant #89).
>
> "Running at group…felt this because I could keep up the same level" (participant #307)
>
> "I was able to perform in a way that made me feel good and satisfied about myself" (participant #316).
>
> "Didn't fall off my bench! Felt pretty special!" (participant #328).

Perceived Autonomy. SDT's conceptualization of perceived autonomy stems from the writings of deCharms (1968) who noted that people have an innate desire to be the "origin" of their behavior rather than a "pawn" to some external agent. According to Ryan (1993), people will experience the feeling of autonomy when there actions are personally endorsed and congruent with their true interests and values. To be included in this category, participants had to describe an experience that indicated they had some degree of choice surrounding their exercise participation or that it was their decision (not someone else's) for them to engage in exercise behavior.

The results of the content analysis procedures applied to the raw data yielded two lower order themes that were thought to reflect experiential aspects of perceived autonomy drawn specifically from exercise contexts. Table 1-2 presents the perceived autonomy dimension in conjunction with the percentage of participants endorsing each lower-order theme. The first theme, labelled "perceived choice", was cited by 27.9% of the coded responses and reflected a sense that the exercise regimen that the participant was involved in had been initiated and sustained by their choice and not externally imposed upon them. The following quotations provide examples of the lower-order theme of perceived choice:

> "I feel autonomous every time I exercise because it is my own choice to be healthy and I value that" (participant #23).
>
> "I always feel autonomous as I always choose my fitness regimes" (participant #308)

The second theme emerging from the content analysis of the responses to the autonomy questions was a sense of personal initiation and personal ownership of the behaviour endorsed by the participant as opposed to being a slave to the whim of external forces or seductive contingencies. In line with previous research and theorizing (deCharms, 1968; Deci & Ryan, 1985; 2002; Reeve, 2002; Ryan 1995), this theme was labeled as an "internal perceived locus of causality" and included statements that indicated a degree of personal decision making and initiation surrounding exercise involvement. This lower order theme comprised 30.6% of the responses in this dimension. The following quotes are presented as examples of the perceived locus of causality theme:

> "Directing my own actions" (participant #146).
>
> "Every time I participate in an exercise session. I wouldn't do this if I didn't want to or if it wasn't in my values" (participant #172).

Perceived Relatedness. SDT's conceptualization of relatedness draws on a diverse array of literature that corroborates the importance of a sense of belongingness (Baumeister & Leary, 1995) or more generally a feeling of being meaningfully attached to other people (Bowlby, 1979; Ryan, 1995). As shown in Table 1-2, five lower order themes emerged from the content analysis depicting experiences that promote a meaningful sense of connection with other people in exercise contexts. The first theme was a sense of connection to others who share similar aspirations or desire comparable achievements in exercise settings and is labeled "similar exercise goals". This theme comprised 7.6% of the coded relatedness responses. Participant quotes that exemplify this lower-order theme of relatedness were as follows:

> "Sharing common interest. Getting two things done at once…socializing and exercising: Motivating one another" (participant #21).
>
> "Teamwork, striving together for the same goal" (participant #69)
>
> "The group I was in got to know each other's goals and reasons for taking the class. If people have similar goals then you feel more connected to them" (participant #177).

The second theme to emerge from the content analysis, comprising 29.7% of the coded responses to the relatedness questions, was labeled "common experiences". The central theme linking these data were responses indicating that participants shared similar personal experiences in exercise contexts or observed other participants enduring similar experiences.

Sample quotes provided by participants that reflected this lower-order category included the following:

> "I feel related when I am in a group exercise. I feel this way because everyone else is going through the same thing I am at that moment" (participant #43).
>
> "Camaraderie-between all the class members because we all know what each other is going through" (participant #78).
>
> "After completing a hard drill or exercise. I felt connected with them because of the experience we made it through together" (participant #80).
>
> "SHARING THE PAIN" (participant #98).
>
> "Only if the instructor and the rest of the class is in agony to. More related if the instructor was struggling, less when the instructor is breezing through the workout" (participant #166).
>
> "Shared pain!" (participant #282).
>
> "I feel related when others are struggling when I struggle because we have something in common" (participant #285).

A "sense of support" from others was the third theme identified from the content analysis of the relatedness data and comprised 9.7% of the coded responses in this dimension. Participants reporting a sense of support as a central quality enhancing feelings of relatedness indicated that the encouragement or assistance they receive from others while they are exercising engendered feelings of connection with others. Sample quotes drawn from the relatedness data depicting examples of support from others include:

> "When everyone helps each other to get the most out of a stretch or exercise" (participant #92).

> "Feeling greatly inferior to the other people would make me feel less related, unless someone specifically helped me in which case I would feel more related" (participant #195).

The fourth theme to emerge from the analysis of the relatedness data in the present study was labelled "group affiliation" and was comprised of 32.1% of the coded response in the relatedness dimension (see Table 1-2). This lower-order theme was characterized by an indication that personal or social affiliation with other people provided a sense of relatedness to others while they exercised. Sample quotes drawn from the relatedness responses that exemplified this experience included:

> "I came with someone I know" (participant #88).
>
> "The togetherness of the group, the freedom to express in a group" (participant #235).
>
> "Working out with a friend---we're sharing an activity together" (participant #9)

The final theme that emerged from the content analysis suggested that not all people wish to feel related when they exercised in group-based classes. This final theme, labeled "No Need for Relatedness" in Table 1-2, was endorsed by only a small number of participants in this study (6.9%) but was characterized by a clear expression of not wishing to feel related to other people while exercising or that feelings of relatedness were not a necessary requirement for them in the context of their exercise participation and involvement. Sample quotes illustrating this lower-order theme included:

> "Don't feel a need to feel related in an exercise session" (participant #33).
>
> "I don't like feeling related" (participant #121)
>
> "Certain classes promote relatedness more than others (i.e., kickboxing) because you're working with others. I don't think it is always necessary in a class however" (participant #119).

"I don't really feel related to others in an exercise class even though the instructor is very helpful. I've never really thought about it before---I am not sure feeling related would be essential to exercise" (participant #176).

"I don't really need to feel related. This is not that important to me" (participant #180).

"I do these sessions strictly for me. I am not interested in feeling related" (participant #191).

"Don't want to be related. This is my escape" (participant #220).

"I am here to workout so I like classes that aren't related" (participant #248).

PNSE Item Development

On the basis of the transcribed data used in the content analysis, twenty-two items were written to represent the constructs of perceived competence, autonomy, and relatedness (see Table 1-3 for the initial set of PNSE items). The same process was used to generate the initial set of 22 items for each need satisfaction construct proposed within SDT. The test writer (Philip M. Wilson) generated each item by examining the content of the participant's responses that comprised each lower-order theme depicted in Table 1-2. As an example of this process, the item "I feel capable of completing the exercises in my workout" (PNSE2 in Table 1-3) was generated on the basis of participant quotations such as the following:

"I feel that I can perform the instructed routines" (participant #10).

"I feel competent when I can do the routines (I'm not terribly co-ordinated) and when I have worked out well but not too hard" (participant #18).

"I was able to master a difficult combination" (participant #58).

The use of items generated from experiential accounts provided by current exercise participants based on the process outlined above was deemed important for two reasons. First, Deci and Ryan (2002) have indicated that the mechanisms promoting need satisfaction can vary according to contextual subtleties. It was therefore considered important to understand what events promoted or detracted from psychological need satisfaction in exercise by people currently participating in that context. Second, psychometricians have advocated the use of input from the target population (in this instance current exercisers) at the initial stages of instrument development (Crocker & Algina, 1986). Such an approach can improve the likelihood that the items developed by the test writer remain both relevant and understandable for the target population intended to be examined with the instrument in future research (Crocker & Algina, 1986; Dunn et al., 1999).

Summary

The purpose of phase 1 was to identify the types of exercise-specific experiences that contribute towards the perceived satisfaction of competence, autonomy, and relatedness needs. Drawing exclusively on SDT's definition of psychological needs, the present study provided insight into the nature of personal experiences within exercise contexts that encourage feelings of competence, autonomy, and relatedness. Although the majority of lower-order themes emerging from the inductive content analysis were consistent with previous research (Kowal & Fortier, 1999; 2000; Markland & Hardy, 1997) and SDT (Deci & Ryan, 1985; 2002; Ryan, 1995), one particularly unique finding pertaining to perceived relatedness was evident in the present study and suggests that the experiential description provided through the content analysis procedures adopted in this phase of study 1 was particularly appealing.

One of the most interesting findings emerging from phase 1 was evident in the content analysis of the relatedness responses, and indicates that some people do not believe it is essential to feel meaningfully connected to others in exercise contexts. Although this finding is inconsistent with SDT's contention that relatedness is a universal psychological need, Vallerand (2001) notes that empirical attention to perceived relatedness in exercise contexts has been "sorely neglected" (p. 287) and recent commentary suggests that our understanding of the structure and function of this psychological need is rudimentary at best (Frederick-Recascino, 2002). One possible explanation for this finding is the existence of a perceived relatedness threshold that only requires general satisfaction rather than context specific appeasement. Vallerand (2001) refers to this hypothesis as the "compensation effect" (p. 313) and argued that the self maintains a homeostatic balance to support and protect its development by drawing on multiple life contexts rather than a solitary domain. Although Vallerand's contention warrants consideration, the majority of participants in this phase did provide examples of events that satisfied relatedness needs in exercise and therefore no serious threat to SDT's assertion regarding the universality of relatedness needs appears evident on the basis of these data.

Phase 2

The purpose of phase 2 was to first assess the relevance of each item in terms of the content domain specified by each psychological need satisfaction construct and then to determine the representativeness of the retained PNSE items. On the basis of previous recommendations (Crocker & Algina, 1986; Dunn et al., 1999; Fitzpatrick, 1983), both qualitative and quantitative procedures were used to evaluate the content relevance (the degree to which an individual item is relevant to a specified content domain or set of domains) and representation (the degree to which an item set or pool adequately covers the breadth of the content domain or domains under study) of the initial set of PNSE items using a panel of "expert" judges. Considering the theoretical and experiential basis from which the PNSE items were developed, it was hypothesized that support for the content relevance and representation of the item set would be obtained through the expert review process.

Method

Participants

Participants in this phase were thirty-two expert judges selected to evaluate the content relevance and representation of the twenty-two PNSE items. The composition of the expert panel was fashioned on the basis of recommendations from previous scale construction guidelines (Crocker & Algina, 1986; Dunn et al., 1999; Fitzpatrick, 1983). Four distinct groups comprised the panel of judges that included expertise in (1) self-determination theory, (2) exercise psychology, (3) exercise instruction, and (4) current exercise participation. Groups 1 and 2 were selected due to their expertise in psychological theory and exercise motivation, while groups 3 and 4 were selected because these individuals have "expert familiarity with the population for whom the test is intended" (Crocker & Algina, 1986, p. 82).

At the time of this study, experts comprising groups 1 and 2 all held a doctoral degree in psychology or a related discipline (e.g., exercise psychology), had a track record of publishing articles on either SDT or applications of psychological theory to exercise behaviour in peer-reviewed journals, and worked in university departments (psychology, physical education, or a related discipline) located in Canada, the United States of America, or the United Kingdom. SDT was the primary research focus of those experts comprising group 1, while the study of exercise adherence from a social cognitive perspective was the central research agenda for Group 2. Two separate groups of theoreticians were chosen to offset potential bias in the item review process associated with acquiescence in the SDT group who may have had a vested interest in the development of the PNSE items. The exercise leaders comprising group 3 had an average of 8.62 years (*SD* 3.20) of instructional experience, held certifications from nationally recognised organisations, and were leading exercise classes at one of three Canadian universities at the time of data collection. The exercise participants comprising group 4 were mostly female (70%), had an average age of 29.27 years (*SD* = 7.25), were participating in a university-based exercise class, and reported exercising on average once per day (*M* = 1.09; *SD* = 0.30) on three or more days per week (*M* = 4.64; *SD* = 1.57) at the time of data collection. None of the experts had any prior involvement in the development of the PNSE items.

Expert Rating Scale Measures

The procedures for quantifying the judge's ratings of each item followed the steps outlined by Dunn et al. (1999) and recommended by Crocker and Algina (1986) for the development and evaluation of survey items. First, the conceptual definitions of perceived competence, autonomy, and relatedness (see Table 1-1) used in phase 1 were presented to the experts. The experts were asked to familiarize themselves with the domain specifications identified by the conceptual definitions thoroughly prior to undertaking the evaluation of the preliminary set of PNSE items.

Once familiar with the domain specifications, the experts evaluated the content relevance of each PNSE item by assessing the degree of congruence between the item content and the domain specifications for competence, autonomy, and relatedness respectively. The following 5-point Likert rating scale was used to evaluate the content relevance of each PNSE item: "1" (Poor Match), "2" (Fair Match), "3" (Good Match), "4" (Very Good Match), and "5" (Excellent Match). The experts provided ratings of each PNSE item to each psychological need satisfaction construct in an attempt to "blind" the judges to the intended item-domain matches and reduce the potential for rating bias to occur during the expert review process (Dunn et al., 1999). After rating each PNSE item against the three content domains, the judges were given the opportunity to provide written comments about each item. The opportunity to provide written comments was deemed valuable at this stage of the scale development process given that the use of mixed method approaches enhances the breadth of available information pertaining to the scale items that can be used to draw conclusions from the expert review process (Crocker & Algina, 1986; Fine & Elsbach, 2000).

The evaluation of content representation followed a similar protocol to the procedures outlined above evaluating item content relevance and was conducted after the experts had evaluated the content relevance of the initial item pool. Messick (1989) notes that content representation concerns the degree to which a set of content-relevant items captures the entire domain (or "conceptual bandwidth") of the construct under investigation. To address the degree of item content representation evident in the initial PNSE items, experts were asked to respond to the following two questions: (a) "How well do you feel all of the items included in the initial item pool represent the constructs of perceived competence, autonomy, and relatedness?" and (b) "Are there any additional items that you feel should be included to represent perceived competence, autonomy, or relatedness?". The first question was scored on the following Likert-type rating scale: (1) "Poor Representation", (2) "Fair Representation", (3) "Good Representation", (4) "Very Good Representation", and (5) "Excellent Representation". The second question was dichotomously scored (1 = "Yes" and 2 = "No"). Both questions were followed by an open-ended dialogue box that provided the experts with an opportunity to comment on their evaluation of the item content representation exhibited by the PNSE items.

Procedures

The expert review process was fashioned on the basis of previous recommendations (Crocker & Algina, 1986; Dunn et al., 1999; Fitzpatrick, 1983). First, all the experts were contacted by e-mail, letter, or telephone to determine their interest in participating in this study. Those experts consenting to participate were sent a copy of the item content review form (ICRF; see Appendix A) that contained instructions for completing the content relevance and representation questions, and returned their assessment of the PNSE items within 6 weeks of the original contact date. Second, the experts numerically rated the degree of content relevance associated with each PNSE item using the item content review procedures outlined in the previous section. Third, the experts were asked to provide written comments pertaining to each item in an attempt to clarify their ratings, and ultimately, to improve the overall quality of the PNSE items. Fourth, the experts numerically rated the degree to which the initial set of PNSE items represented the constructs of perceived competence, autonomy, and relatedness in exercise contexts. Finally, the experts provided written comments pertaining to the degree to which the initial PNSE items adequately represented the domains of perceived competence, autonomy, and relatedness in exercise contexts.

Data Collection

All data were collected between January and March 2002. The majority of experts (> 90%) choosing to participate in this phase of the study communicated with the test writer (Philip M. Wilson) via e-mail and completed the ICRF electronically. Two experts returned their written ICRF responses via regular mail. All numerical data were coded using SPSS Version 11.0. All written data were transcribed verbatim and saved as one word processing file using Microsoft Word as the software package.

Data Analysis

Data analysis for this phase of study 1 proceeded in four stages. First, an initial screening of the experts' responses was conducted to identify discrepant raters or missing cases that could adversely influence the rating procedures. Experts were deemed to have provided discrepant evaluations of the item set if their ratings deviated sufficiently from those of the other judges that the "validity" of the numerical procedures used to evaluate the item-domain matches would be adversely affected (Hambleton, 1980). Discrepant evaluations were determined by calculating the distance of each judge's rating for each PNSE item from the median rating (JDM). JDM values approximating zero were considered desirable since they indicate consistent agreement amongst the expert ratings. Aberrant judges were identified on the basis of their observed JDM scores and their comments were evaluated to determine the source of the discrepancy in their ratings.

Second, descriptive statistics were calculated to provide an intuitive feel for the degree of ambiguity inherent in the expert ratings of the PNSE items and degree of relevance associated with the item-content match. Third, the statistical procedures outlined by Aiken (1985) and Cohen (1977) and advocated by Dunn et al. (1999) were employed to quantify the item-content matches. Aiken (1985) suggested that the content validation process could be improved by statistically assessing the item content relevance ratings provided by expert judges. Therefore, Aiken's (1985) item content validity (*V*) coefficient and Cohen's (1977) effect size (*ES*) for dependant means were calculated to assess distinct aspects of item-content relevance.

Aiken's item content validity coefficient (*V*) provides a statistical test of the fit of the judges' ratings for the domain specification each item was originally intended to measure (Aiken, 1985). *V*-coefficients range from 0 to 1 with a value closer to 1 indicating greater congruence between the item content and intended domain. The statistical significance of each *V*-coefficient was established by comparing the resultant values against a right-tailed binomial probability table provided in Aiken (1985). Although Aiken's *V* is informative, it does not provide information pertaining to the degree to which the content expressed within each item matches non-keyed or unintended domains. Therefore, to provide a preliminary gauge of the extent to which the item content matches both keyed and non-keyed domains, a series of planned mean contrasts ($n = 2$) were computed between the mean content relevance score for the intended domain (the keyed construct) and the other two domains (the non-keyed constructs) outlined in the domain specifications. Each planned contrast was assessed using Cohen's effect size (*ES*) for dependant means (d_z). The calculation of *ES*'s provides valuable information regarding the practicality of the mean differences observed, and have been recommended by a number of psychometricians given that they provide information beyond merely the statistical significance of an observed effect (Cohen, 1992; Huberty, 2002).

The evaluation of item content representation was conducted after the item content relevance analyses was completed, and involved screening for discrepant experts using the JDM procedure, calculation of descriptive statistics and Aiken's *V*-coefficients in accordance with previous suggestions (Aiken, 1985; Dunn et al., 1999). Following the statistical evaluation of the PNSE item set, an inspection of the experts written feedback for both relevance and representation questions was used to determine if alterations should be pursued with any of the PNSE items.

Results

Preliminary Data Analysis Screening for Discrepant Raters

Table 1-4 provides a summary of the response rates provided by the expert judges drawn from each of the four groups used in this study. The overall response rate considering the initial number of experts approached to be involved in the study was 62.5%. One of the experts (from group 2) who did not participate in this study indicated she lacked the necessary expertise to complete the ICRF, and five experts originally intended to form part of group 1 indicated that they did not have sufficient time to participate in the study. Nine experts returned the ICRF without numerically evaluating all 22-PNSE items (five from group 1, one from group 2, and three from group 3). These judges were deemed non-respondents and excluded from further analyses.

Prior to conducting the statistical analyses concerning item content relevance, the experts' ratings were screened for discrepancies by examining the distance from the median for each judges' rating (JDM) on each PNSE item. The JDM scores should approximate zero indicating agreement amongst the experts in their rating of the item. Experts were considered to be aberrant judges if their JDM scores were markedly different compared to the values provided by the other experts comprising their group. An inspection of the JDM scores per group revealed the following patterns: (1) 9 of experts from group 1 had JDM values between 5 and 20 (1 expert's JDM = 34); (2) 8 of experts from group 2 had JDM values between 5 and 18 (2 experts JDM values ≥ 22); (3) 6 of the experts from 3 had JDM values between 2 and 25 (4 of the experts JDM scores > 37); and (4) 9 of the experts from group 4 had JDM scores between 2 and 20 (1 expert had a JDM score of 43). Eight of the experts were deemed aberrant judges on the basis of their observed JDM scores. Of these eight experts, no specific written comments accounted for their discrepancy but suggested modifications to the original PNSE items were provided for consideration. The eight discrepant judges were removed from the expert pool prior to conducting the statistical evaluation of item content relevance.

Quantitative Content Relevance Ratings for PNSE Items

Item ambiguity associated with expert ratings was assessed through the calculation of the range (highest minus lowest rating plus 1) of ratings provided by each group of experts across the 22 PNSE items. Range (R) values closer to 1 are desirable indicating there is minimal ambiguity inherent in the expert ratings across of the set of items under consideration. An inspection of the R-values (see Table 1-5) indicated that 7 of the 22 PNSE items had ambiguous ratings (R values ≥ 4). A closer inspection of the data revealed that none of the ambiguous item ratings were attributable to group 1, 18.18% were attributable to group 2, 36.36% were provided by group 3 and the majority (45.45%) of the ratings contributing to item ambiguity were attributable to group 4. Collectively, these data raise concerns regarding the clarity expressed by 8 of the original 22 PNSE items.

A statistical evaluation of the PNSE items recommended by Dunn et al. (1999) was conducted. Table 1-6 contains the mean content-relevance ratings of each item per keyed domain for each group of experts and for the overall set of expert ratings. As can be seen from the data provided in Table 1-6, the majority (94.32%) of the mean-item content relevance ratings had values of 4.0 or greater indicating a very good match between the item content and the keyed domain. These data provide preliminary evidence supporting the content relevance of the initial PNSE items, especially given that the five ratings that were less than 4.0 still exceeded the theoretical midpoint of the rating scale (i.e., > 3.0).

Although these initial content-relevant ratings are encouraging, they do not provide a statistical evaluation of the degree of item content relevance associated with the initial 22-items comprising the PNSE. Consequently, both Aiken's (1985) item content validity coefficient (*V*) and Cohen's *ES* for dependant means were examined. Aiken's *V* coefficients were calculated per item across each group of judges. The results of this analysis (see Table 1-7) indicated that all 88 *V*-coefficients were statistically significant suggesting each item comprising the PNSE was relevant to the content of their keyed domain. Cohen's *ES* for dependent means (d_z') was calculated to determine the extent to which each PNSE item also captured aspects of non-keyed domains. Dunn et al. (1999) suggest this process is analogous to examining the latent dimensionality of an established (or emergent) set of items and provides an "intuitive feel" (Dunn et al., 1999, p. 28) for the item dimensionality at an early stage in the instrument development process. Planned mean contrasts were computed between the keyed domain (construct that the item was intended to measure) and the non-keyed domains (the constructs the item was not intended to measure). ES's were computed for the combined mean-content relevance scores provided by all 32 expert judges. The results of this analysis (see Table 1-8), were interpreted within the framework of Cohen's (1977) guidelines concerning small ($d_z' < .49$), medium ($d_z' = .50$ to .79), and large ($d_z' > .80$) *ES*'s. An inspection of the d_z' values presented in Table 1-8 indicates that all of the ES's could be considered large in nature. Taken together with the mean content relevance ratings, and the observed *V*-coefficients, these data provide initial statistical support for the content relevance of the 22-item PNSE.

Qualitative Content Relevance Comments for PNSE Items

Although the statistical evidence pertaining to item content-relevance is promising at this stage, Fine and Elsbach (2000) point out that the reliance on any single type of data seems methodologically unjust given that critical insights could be overshadowed by using a solitary data source. Dunn et al. (1999) point out that providing judges with the opportunity to comment on the item content at this stage of the scale development process can be valuable, and therefore, an examination of the judges' written comments was undertaken.

Although the prevalence of comments varied across the initial set of 22-PNSE items (see Table 1-9), an inspection of the written feedback provided by the experts pertaining to both the autonomy and competence items suggested the presence of wording problems associated with the content of the initial PNSE items. Of the experts providing written feedback, 20.7% of the comments pertaining to the competence items and 33.7% of the comments pertaining to the autonomy items indicated that the initial wording was overly factual rather than experiential in nature. For example, in commenting on Item 18 ("I am able to perform each exercise correctly"), one expert indicated: "Too much focused on a standard—good/bad. I don't need to do it correctly. I feel good about the way I am able to perform each exercise" (expert judge #1).

In contrast to the competence and autonomy items, an examination of the experts' comments regarding the relatedness items suggested two particular areas of concern pertaining to the construct validity of the initial PNSE items. First, 15.3% of the experts' comments indicated that the relatedness items as they were currently worded were abstract in terms of the target source from which feelings of relatedness were derived. For example, one judge indicated that "Relatedness in the description is about feeling connected to the people around you while you are exercising. In this item [referring to item 13 "I feel supported by people who are important to me when I exercise"] the "people who are important to you" may not be with you at this time. It's confusing as to what people you are referring to…". Second, 25.8% of the experts' comments indicated concerns regarding the use of unnatural language expressed by the content of the PNSE-Relatedness items. For example, one expert commenting on item 9 ("I feel affiliated to other people when I exercise") noted that "I like the item, but is the term "affiliated" to educated (dumb it down somewhat?)" (expert judge #12).

Quantitative Content Representation Ratings for PNSE Items

An examination of the experts JDM values for content representation was undertaken to identify discrepant raters using the procedures previously described for content relevance. The results of this analysis suggested no need to remove additional judges beyond those discarded from the item content relevance stage of this analysis. The following JDM values were observed: (1) Group 1's JDM values ranged from 1 to 4; (2) Group 2 and 3's JDM values ranged from 0 to 3; (3) Group 4's JDM values ranged from 0 to 5. Overall, 78.2 % of the JDM values for the total sample fell between 0 and 2 corroborating the decision not to discard additional experts beyond those removed in the item content relevance stage of this analysis.

Consistent with the procedures evaluating item content relevance, item ambiguity inherent in the expert ratings of the PNSE items was assessed using R-values. An inspection of the data (see Table 1-10) indicated minimal ambiguity in terms of the experts' ratings of content representation (all R-values ≤ 3) although it is acknowledged that some ambiguity exists in the ratings most notably for groups 2 and 4 in the present study. A closer inspection of the data, however, indicated that no judge in either group 2 or 4 provided an ambiguous rating on more than one content domain question. An inspection of the percentage of experts in each group providing R-values less than 2 in response to the content representation questions for each psychological need satisfaction construct revealed the following: (1) Group 1 = 90% to 100%; (2) Group 2 = 80% to 100%; (3) Group 3 = 90% to 100% ; and (4) Group 4 = 80% to 100%.

The mean content-representation ratings for the initial item pool are presented in Table 1-10. An examination of the descriptive statistics (see Table 1-10) indicates that content-representation scores were consistently high both in the total sample as well as in each group of experts, suggesting preliminary support for the representation of the content associated with perceived competence, autonomy, and relatedness in exercise by the PNSE items. An inspection of Aiken's V-coefficients (see Table 1-11) indicated that all values were statistically significant ($p < .05$ in all instances), and taken together with the descriptive statistics provides initial support for the degree to which the initial set of PNSE items adequately represents the content of the psychological need satisfaction constructs proposed within SDT (Deci & Ryan, 1985; 2002).

Analysis of the second content representation question revealed that the majority of experts in the total sample (70.0%) indicated no additional items needed to be added to enhance the representation of perceived psychological need satisfaction constructs in the set of PNSE items. Inspection of the data (see Table 1-12) indicated that only the experts in group 1 (self-determination theorists) suggested that additional items were needed to adequately represent the construct of competence, autonomy, and relatedness in exercise contexts although none of the experts comprising this group provided specific items that would accomplish this task.

Qualitative Content Representation Comments for PNSE Items

Although the statistical results provide preliminary support for the representation of psychological need satisfaction constructs drawn from SDT by the initial PNSE items, an examination of the written feedback provided by 27 of the 32 experts indicated that some improvements could be made prior to subsequent use of the PNSE. Of the experts providing written feedback on the content represented by the initial PNSE items, 25.9% of the comments expressed concern regarding the degree of representation evident in the relatedness items. One expert summarized the central concern with the degree of content representation demonstrated in the PNSE relatedness by noting "I wonder if you are capturing all aspects of the construct? At times it appears that a word has been replaced with another word of similar meaning. My only concerns are "word choice" for a few items and *whether you have completely captured the universe or domain by your items*" (expert judge #14, italics added). Elaborating further on the relatedness items, another expert indicated that "I think there needs to be careful consideration of what the items convey. For example, are you suggesting that people feel involved with those that they exercise with, or are you asking about a "we are the world" type of involvement sense with others who are not present, not exerciser, etc" (expert judge #6).

With regards to the competence and autonomy items, 18.5% of the experts' written comments indicated that improvements could be made to enhance the representation of the autonomy and competence items comprising the PNSE. One expert noted that the competence items should "capture the feeling that you feel really capable in the exercise setting in the same way that you feel really capable at your job" (expert judge #16), while another expert indicated that "I feel that choice for exercise is less important than feeling volitional for exercise: wanting to do it, valuing it, doing it because of interest, etc" (expert judge #18). Overall, the quantitative data supports the content represented by the initial set of PNSE items; however, the nature of written feedback provided by the experts suggests that improvements to the initial PNSE items warrant careful consideration prior to using them in subsequent research.

Item Modifications

Despite the supportive results of the expert rating procedures examining both content relevance and representation of the initial set of PNSE items, a series of item modifications were made on the basis of the expert's comments. An inspection of the written comments addressing the content representation of the initial PNSE items indicated that 18.5% of the responses called for a combined theoretically-driven and open-ended approach to the development of each PNSE item. One expert noted that "I'm not sure to what extent the items are based on the open-ended responses, but I think a combined theoretically based development of the items would also help (you've probably already done this, but I think a combined open-ended/theoretically driven item generation is the strongest approach" (expert judge #2). Given that measurement experts do support the use of theoretical information in the process of scale construction (Crocker & Algina, 1986), the relevant theoretical (Deci & Ryan, 1985; 2002; Reeve, 2002; Ryan, 1995; Sheldon, 2002) and applied literature (Kowal & Fortier, 1999; 2000; Markland, 1999; Markland & Hardy, 1997) was consulted in an attempt to either modify existing PNSE items or replace them with new items.

With regards to the perceived competence items, two modifications were made from the initial set of PNSE items. The first modification was to more clearly incorporate the notion of personal challenge into the content of the items given that a sense of meeting personal challenges is central to SDT's conceptualisation of perceived competence and clearly pertinent to the experience of perceived competence in exercise contexts (see Table 1-2). Given that only one of the original six PNSE items conveyed a sense of challenge in the item content, the remaining five items were re-written to be more consistent with SDT's construal of perceived competence. As an example of this process, the initial PNSE item "I am able to perform each exercise correctly" was changed to "I feel that I am able to complete exercises that are personally challenging to me". The second modification made to the perceived competence items was to enhance the experiential quality of the item content since PNSE items 4 and 5 (see Table 1-3) were clearly factual rather than experiential in nature. This was accomplished for all the PNSE items by using the phrase "I feel" as the initial starting point for each item. An example of this modification to the PNSE item content was changing PNSE4 "I am able to complete difficult exercises" shown in Table 1-3 to PNSE6 "I feel good about the way I am able to complete challenging exercises" (see Table 1-13 for the final set of PNSE items).

Although one of the initial PNSE-Autonomy items was slightly modified (PNSE15 in Table 1-3 – "I feel free to exercise my own way" became "I feel free to exercise in my own way"), the other eight PNSE items were modified or deleted and re-written. Of the three original items designed to capture the internal locus of causality aspect of perceived autonomy (PNSE items 7, 8, & 13 shown in Table 1-3), PNSE7 was modified from its original form to "I feel like I am the one who decides what exercises I do" and the other two PNSE items were replaced with "I feel like I am in charge of my exercise program decisions" to capture the experiential aspects of the construct. Second, PNSE items 14 and 15 (in Table 1-3) were replaced with "I feel free to make my own exercise program decisions". This final item was retained along with the minor modification noted above to PNSE15 to capture the volitional aspect of autonomy deemed important by Reeve (2002). Finally, PNSE9 ("I choose the exercises that I do") was modified to enhance the experiential content of this perceived choice item (PNSE11 in Table 1-13). PNSE10 was modified to read "I feel like I have a say in choosing the exercises that I do", and PNSE12 was deleted from the original item pool given that the content expressed in this item (namely perceived choice) was adequately captured in the final version of the PNSE by items PNSE10 and PNSE11 shown in Table 1-13.

Finally, the perceived relatedness items were completely re-written keeping in mind the results of the content analysis reported in phase 1 and the available literature pertaining to the factors contributing towards enhanced feelings of perceived relatedness at the time of item writing. One study by Reis et al. (2000) noted that while the scope of relatedness experiences is diverse, it includes a number of sources that appear relevant to exercise contexts including participating in shared activities, feeling understood or appreciated by empathic others, and interacting with others who acknowledge your point of view. Six items were written to retain the balance of the scale and represent the content of perceived relatedness derived from participating in a shared activity (PNSE14 and PNSE15 in Table 1-13), feeling understood and appreciated by those you exercise with (PNSE13 and PNSE16 in Table 1-13), and interacting with other people who share or accept your viewpoint (PNSE17 and PNSE18 in Table 1-13).

Summary

The purpose of phase 2 was to provide evidence attesting to the relevance and representation of the initial set of PNSE items using expert rating procedures advocated by measurement development experts in the process of instrument construction and evaluation (Crocker & Algina, 1986; Dunn et al., 1999; Fitzpatrick, 1983). Using a mixed-methodological approach, the results of phase 2 suggest that the initial PNSE items were promising measures of perceived psychological need satisfaction for competence, autonomy, and relatedness needs in exercise contexts within the framework of SDT. An inspection of the quantitative data derived from the expert review process indicated that the initial set of PNSE items appears to be both relevant and representative of the focal constructs of interest within the context of exercise. Notwithstanding this finding, the written comments provided largely by Group 1 (SDT experts) during the expert review process led the test writer to modify the initial PNSE items on the basis of theoretical considerations and expert comments in an attempt to improve the content of the PNSE items. Although the procedures responsible for the development of the final PNSE items do not assure construct validity of the instrument (Bursich, 1984), the development of the PNSE items was rigorous and critical in accordance with Lynn's (1986) recommendations for the assessment of content validity.

Study 1 – General Discussion

The purpose of this study was to explore the types of experiences that facilitate psychological need satisfaction from the perspective of SDT in exercise contexts, and evaluate the relevance and representation of an initial set of items designed to measure perceived competence, autonomy, and relatedness in exercise contexts. The first phase of this study provided illustrative examples of the array of experiences people report in exercise contexts when they feel competent, autonomous, and related, and suggested that perceived relatedness may not be a "crucial" experience for all participants engaged in structured exercise classes. The results of phase 2 of this study suggested that the preliminary set of PNSE items developed in phase 1 were both relevant to the psychological need satisfaction construct they were originally designed to measure, and representative of the domain of psychological need satisfaction from the perspective of SDT in exercise contexts. Despite the favourable quantitative results attesting to the content relevance and representation exhibited by the initial PNSE items, the mixed-method approach used in study 2 provided insights into some potential shortcomings with the PNSE items that led to a number of refinements being made to modify the original set of PNSE items.

An inspection of the results from the first phase of this study suggested that the majority of experiences reported by participants engaged in structured exercises classes are in line with major theoretical arguments central to SDT (Deci & Ryan, 1985; 2002; Ryan, 1995), as well as, previous research into the nature (Markland & Hardy, 1997) and function (Kowal & Fortier, 1999; 2000; Markland & Hardy, 1997; Wilson et al, 2002a; 2002b) of need satisfaction in exercise. The results of phase 1 extend previous applications of SDT to exercise contexts by exploring the types of experiences that facilitate feelings of perceived relatedness and represent an initial step in addressing calls for more research into this aspect of SDT (Frederick-Recascino, 2002; Vallerand, 2001). Overall, the results of phase 1 extend previous research on need satisfaction in exercise contexts from the perspective of SDT by providing illustrative examples of the specific experiences within exercise contexts that promote feelings of competence, autonomy, and relatedness.

One controversial finding emerging from phase 1 of this study was that endorsement of relatedness as a necessary experiential quality within structured exercise classes was not unanimously supported. An examination of the results of the content analysis suggested that some participants did not wish to feel related to others in the exercise context. While this finding may simply be an artefact of the exercise setting from which the participants were recruited, an alternative explanation is that relatedness needs do not require satisfaction in all facets of life. Vallerand (2001) has termed this concept the "compensation effect" and suggests that the self may simply require a "threshold" of need satisfying experiences across relevant life domains in order to retain functional status and healthy development. While Vallerand's contention is appealing, it fails to account for the universality of basic psychological needs posited within SDT (Deci & Ryan, 1985; 2002; Ryan, 1995).

Consequently, this conclusion should be tempered with some caution until further research has carefully examined Vallerand's contentions regarding satisfaction of relatedness needs.

Aside from the explanation, this finding is not completely detached from previous exercise research and could account for the observation that relatedness needs are less satisfied in structured exercise contexts than either competence or autonomy needs (Wilson et al., 2002a; 2002b). Although the theoretical ramifications of these findings warrant more careful examination in future research, a major practical implication of the present results concerns the viability of intervention programs based solely on social mechanisms as a vehicle for promoting self-determined exercise regulation and behavior. Assuming that feeling related in exercise contexts is not a ubiquitous requirement for exercisers, these data question the merit of intervention programs designed to promote exercise behavior and motivational development by facilitating only feelings of relatedness which on the basis of the present data may lead to undesirable effects. Future research would do well to evaluate this contention carefully by examining the degree to which people need to feel related in a broader array of exercise contexts, and the long-term effects of carefully designed interventions geared towards promoting relatedness on motivational development and exercise participation.

Consistent with previous research and commentary calling for more rigorous assessment of content validity (Crocker & Algina, 1986; Dunn et al., 1999; Lynn, 1986), the overall findings emerging from the statistical analyses conducted in study 2 indicated that each original PNSE item was both relevant to, and representative of, the psychological need satisfaction constructs contained with SDT's framework. Although evidence of "item suitability" does not guarantee the validity of the inferences to be drawn from scale scores (Burisch, 1984), the procedures used in phase 2 provide an example of one approach to instrument construction that can reduce the likelihood of developing unsuitable items. Given that the measurement of psychological need satisfaction is the subject of considerable debate (Sheldon, 2002), and the shortcomings of existing measures of need satisfaction in exercise contexts (Markland & Hardy, 1997), it seems reasonable to suggest that the PNSE holds some promise for the exploration SDT based hypotheses despite the considerable modifications made to the original PNSE items.

On the basis of recommendations made by Dunn et al., (1999), phase 2 of this study provided evidence attesting to the viability of both item content relevance and representation for the original PNSE items which are commonly overlooked aspects of instrument development and content validity research. Given that calls for more rigorous and systematic assessment of content validity have been forthcoming (Crocker & Algina, 1986; Dunn et al., 1999; Lynn, 1986), it seems prudent to suggest that future scale construction research assess both the relevance and representation of newly developed items since failure to fully represent the focal construct of interest may have insidious effects on scale score interpretation. In line with this contention, it seems that an atheoretical approach to item construction would pose numerous challenges given that domain clarity around the keyed constructs would be difficult to establish and thereby full representation of the construct would be more than a challenging undertaking.

On a final note, the results of phase 2 make it apparent that useful information can be gained from a number of sources in the process of scale construction when using a mixed-method approach to item evaluation and development. An examination of the quantitative data from phase 2 of this study supported the relevance and representation attributable to the original set of PNSE items. An inspection of the written comments, however, provided a convincing argument for the modification and re-writing of the initial PNSE items for the purposes of adequately capturing perceived psychological need satisfaction from the perspective of SDT. One obvious problem with this mixed-method approach is the potential for contradiction across item evaluation methods. Despite this shortcoming, the provision of opportunities for structured (i.e., numerical ratings) and unstructured (i.e., open-ended commentary) evaluation of item content seems to be a useful approach in social psychological research given that "every methodological choice involves benefits and drawbacks" (Fine & Elsbach, 2000). Since the process of establishing construct validity is ongoing (Messick, 1989; 1995), test writers should consider employing various sources of evidence during the preliminary stages of instrument development such that important components of the construct are not overlooked.

Limitations and Summary

Although several interesting findings emerged from this study, a number of limitations are evident and should be discussed along with suggestions for future research to advance our understanding of psychological need satisfaction in exercise from the perspective of SDT. While the results of phase 1 of this study highlight the breadth and diversity of need satisfying experiences operating in exercise contexts, the structured approach used to generate the data prohibited participants from commenting on other "potential" psychological needs that may be important in exercise contexts. Recent research suggests that experiences defined as personally satisfying (Sheldon et al., 2001) rest on more than perceived competence, autonomy, and relatedness. Therefore, future research could examine the degree to which psychological needs external to SDT's framework play a role in positive exercise experiences and motivational processes.

In addition to the limitations imposed by the data collection method employed in phase 1, a major limitation of phase 2 of this study is the inability to determine the degree to which individual items are representative of their intended domains (competence, autonomy, and relatedness) rather than the domain of psychological need satisfaction more generally. Although phase 2 did address the notion of content representation which was identified by

Dunn et al. (1999) as a limitation of previous research on content validity, the questions surrounding content representation in the present study did not afford the opportunity to evaluate the degree to which each need satisfaction construct was adequately represented by the PNSE items. Future research could address this issue more carefully by questioning the extent to which each individual item fully represents the domain it was designed to measure as opposed to the degree to which the overall set of items represents the domains of perceived competence, autonomy, and relatedness in exercise contexts.

In summary, the overall purpose of this study was to explore the experiential qualities of exercise that promote (or thwart) need satisfying experiences and to develop and evaluate a preliminary set of items designed to capture the essence of psychological need satisfaction in exercise from the vantage point of SDT (Deci & Ryan, 1985; 2002; Ryan, 1995). Overall, the findings from phase 1 suggest that a broad array of experiences contribute towards feelings of competence, autonomy, and relatedness in structured exercise contexts, while the results of study 2 suggest some support for the content relevance and representation of the initial set of PNSE items.

Table 1-1.

Constitutive Definitions for Psychological Need Satisfaction Constructs

Dimension of Psychological Need Satisfaction	Domain specifications Need Satisfaction Constructs
Competence	These items are intended to capture whether the participant perceives that they are capable of performing or completing challenging exercises effectively.
Autonomy	These items are intended to capture whether the participant perceives that the exercises they do reflect their own choices and values, and are undertaken volitionally without external coercion.
Relatedness	These items are intended to capture whether the participant perceives they are meaningfully connected with other people in the social environment while they are exercising.

Table 1-2.

Percentage and Frequency of Lower-Order Themes

Dimension *Lower Order Theme*	*Dimension*		*Lower-Order Themes*	
	%	*n*	*%*	*n*
Perceived Competence	88.8	294		
Optimal Challenge			12.7	42
Personal Appraisal of One's Abilities			43.6	144
Perceived Autonomy	80.3	265		
Perceived Choice			27.9	74
Internal Perceived Locus of Causality			30.6	81
Perceived Relatedness	86.4	285		
Similar Exercise Goals			7.6	25
Common Experiences			29.7	48
Sense of Support			9.7	32
Group Affiliation			32.1	106
No Need for Relatedness			6.9	23

Note. The value listed under dimension represents the percentage of the total sample that provided a response to the open-ended probe question. The values listed for each lower-order theme represent the percentage of participants citing that particular theme within a specific dimension. The percentage of lower-ordered themes does not sum to equal the values reported in the dimension column because not all of the data provided by the participants was coded.

Table 1-3.

Initial PNSE Items Designed from Open-Ended Responses

PNSE – Perceived Competence

PNSE1 - I feel competent in my ability to successfully complete each exercise
PNSE2 - I feel capable of completing the exercises in my workout
PNSE3 - I feel capable of completing challenging exercises
PNSE4 - I am able to complete difficult exercises
PNSE5 - I am able to perform each exercise correctly
PNSE6 - I feel competent in the exercises I attempt

PNSE – Perceived Autonomy

PNSE7 - I am personally responsible for the exercise that I do
PNSE8 - I personally initiate the exercise that I do
PNSE9 - I choose the exercises that I do
PNSE10 - I feel that I have a say in the exercises that I do
PNSE11 - I feel autonomous in the exercises that I do
PNSE12 - I feel that the exercises I do reflect my personal choices
PNSE13 - I pick the exercises that I want to do
PNSE14 - I feel that exercise is something I do willingly
PNSE15 - I feel free to exercise my own way

PNSE – Perceived Relatedness

PNSE16 - I feel connected to people with similar exercise goals when I workout
PNSE17 - I feel involved with other people when I exercise
PNSE18 - I feel related to other people when I exercise
PNSE19 - I feel affiliated to other people when I exercise
PNSE20 - I feel supported by people who are important to me when I exercise
PNSE21 - I feel a sense of attachment to others when I exercise
PNSE22 - I feel included by other people when I exercise

Table 1-4.

Expert Response Rates per Group

Variable	Group 1	Group 2	Group 3	Group 4
Number of Experts Approached	20	20	20	20
Number of Experts Returning Rating Forms	15	12	13	10
Response Rate	75%	60%	65%	50%
Usable Expert Rating Forms	14	10	10	10
Final Sample of Experts per Group	9	8	6	9

Note. Group 1 = SDT experts; Group 2 = Exercise Psychologists; Group 3 = Exercise Instructors; Group 4 = Exercise participants.

Table 1-5.

R-Ratings Assessing Item Ambiguity Amongst Expert Ratings Across PNSE Items

	R-Values														
	Total Sample			Group 1			Group 2			Group 3			Group 4		
Item[a]	[c]	[a]	[r]	[c]	[a]	[r]	[c]	[a]	[r]	[c]	[a]	[r]	[c]	[a]	[r]
1. PNSE16 [r]	2	1	3	2	1	2	2	1	1	1	1	3	1	1	2
2. PNSE7 [a]	**5**	3	1	2	3	1	2	2	1	1	3	1	**5**	2	1
3. PNSE8 [a]	**4**	3	1	3	3	1	2	2	1	3	2	1	**4**	1	1
4. PNSE1 [c]	2	3	2	2	3	2	2	3	2	2	1	1	2	2	2
5. PNSE17 [r]	**4**	**4**	2	1	2	2	1	1	2	1	**4**	2	1	2	2
6. PNSE18 [r]	1	2	3	1	2	2	1	1	2	1	1	3	2	2	2
7. PNSE9 [a]	2	2	1	1	2	1	2	2	1	3	1	1	2	2	1
8. PNSE2 [c]	3	3	2	2	2	1	2	3	1	2	1	1	2	2	2
9. PNSE19 [r]	2	3	3	1	2	3	1	1	3	1	3	1	1	2	2
10. PNSE3 [c]	1	3	2	1	2	1	2	2	1	2	1	1	1	3	2
11. PNSE4 [c]	2	3	2	1	2	1	2	2	1	2	1	1	2	3	2
12. PNSE10 [a]	2	2	2	1	2	1	1	2	2	1	2	1	1	3	1
13. PNSE20 [r]	1	**4**	**5**	2	3	3	3	3	**4**	1	**4**	**5**	1	2	**5**
14. PNSE11 [a]	3	3	**4**	1	2	1	2	3	1	2	2	**4**	2	3	2
15. PNSE12 [a]	2	2	2	2	2	1	2	2	1	1	2	1	2	2	2
16. PNSE13 [a]	2	3	2	2	3	1	2	2	1	1	1	1	2	2	2
17. PNSE14 [a]	2	**4**	2	1	3	1	2	1	1	1	**4**	1	2	2	2
18. PNSE5 [c]	2	3	2	1	1	2	2	2	1	2	1	1	2	3	1
19. PNSE21 [r]	2	3	2	1	1	3	1	2	3	1	2	2	2	3	3
20. PNSE15 [a]	3	3	2	1	2	2	3	3	2	2	2	1	3	2	2
21. PNSE6 [c]	2	2	2	2	2	1	2	1	1	1	1	1	1	3	2
22. PNSE22 [r]	2	2	**4**	1	1	2	2	2	**4**	1	2	1	1	1	**4**

Note: Group 1 = SDT experts; Group 2 = Exercise Psychologists; Group 3 = Exercise Instructors; Group 4 = Exercise participants. [a]Letters in parentheses identify the latent construct that each item was originally written to measure ([c] = Perceived Competence; [a] = Perceived Autonomy; [r] = Perceived Relatedness). Bold R-values are considered discrepant values.

Table 1-6.

Mean Item Content-Relevance Ratings for Domain Specifications That Each PNSE Item was Originally Intended to Measure

		Judges									
		Group 1		Group 2		Group 3		Group 4		Total Sample	
Item	Content Domain	M	SD	M	SD	M	SD	M	SD	M	SD
1.	PNSE16 [r]	4.60	0.52	4.80	0.62	4.50	0.85	4.80	0.42	4.68	0.59
2.	PNSE7 [a]	3.90	0.88	4.90	0.32	4.70	0.67	4.90	0.32	4.60	0.71
3.	PNSE8 [a]	4.10	0.74	4.60	0.52	4.90	0.32	4.90	0.32	4.65	0.54
4.	PNSE1 [c]	4.90	0.32	4.60	0.52	4.50	0.53	4.60	0.52	4.65	0.16
5.	PNSE17 [r]	4.60	0.52	4.80	0.42	4.80	0.42	4.90	0.32	4.78	0.42
6.	PNSE18 [r]	4.70	0.48	4.90	0.32	4.60	0.84	4.80	0.42	4.75	0.52
7.	PNSE9 [a]	4.80	0.42	4.90	0.32	4.90	0.32	4.70	0.48	4.83	0.30
8.	PNSE2 [c]	4.70	0.48	4.60	0.52	4.60	0.52	4.90	0.32	4.70	0.30
9.	PNSE19 [r]	4.40	0.79	4.60	0.69	4.90	0.32	4.80	0.42	4.68	0.57
10.	PNSE3 [c]	4.90	0.32	4.90	0.32	4.80	0.42	4.80	0.63	4.88	0.23
11.	PNSE4 [c]	4.80	0.63	4.90	0.32	4.80	0.42	4.90	0.32	4.83	0.38
12.	PNSE10 [a]	4.70	0.48	4.60	0.69	4.80	0.42	4.60	0.69	4.68	0.57
13.	PNSE20 [r]	4.20	0.92	3.80	1.03	3.90	1.29	3.70	1.70	3.90	1.24
14.	PNSE11 [a]	4.60	0.52	4.70	0.68	4.90	0.32	4.80	0.63	4.78	0.53
15.	PNSE12 [a]	4.70	0.48	4.80	0.42	4.60	0.52	4.70	0.48	4.95	0.22
16.	PNSE13 [a]	4.50	0.71	4.60	0.69	4.80	0.63	4.90	0.32	4.70	0.61
17.	PNSE14 [a]	3.90	1.10	4.80	0.63	4.60	0.69	4.80	0.42	4.53	0.82
18.	PNSE5 [c]	4.80	0.63	4.60	0.52	4.70	0.48	4.90	0.32	4.83	0.45
19.	PNSE21 [r]	4.40	0.69	4.60	0.69	4.60	0.69	4.60	0.97	4.55	0.75
20.	PNSE15 [a]	4.70	0.68	4.50	0.71	4.50	0.85	4.90	0.32	4.65	0.66
21.	PNSE6 [c]	4.80	0.42	4.60	0.52	4.90	0.32	4.80	0.63	4.88	0.40
22.	PNSE22 [r]	4.40	0.69	4.00	1.05	4.70	0.48	4.50	0.97	4.40	0.84

Note: Group 1 = SDT experts; Group 2 = Exercise Psychologists; Group 3 = Exercise Instructors; Group 4 = Exercise participants. Ratings were done on a 5 point Likert scale ranging from 1 = "Poor Match" to 5 = "Excellent Match".

Table 1-7.

Aiken's V-Coefficients for Judges' Ratings on the Keyed Domain for Each PNSE Item

Item[a]	Judges[b] Group 1	Group 2	Group 3	Group 4
1. PNSE16 [r]	0.90	0.95	0.88	0.95
2. PNSE7 [a]	0.73	0.98	0.93	0.98
3. PNSE8 [a]	0.78	0.95	0.98	0.95
4. PNSE1 [c]	0.98	0.98	0.95	0.98
5. PNSE17 [r]	0.90	0.95	0.95	0.98
6. PNSE18 [r]	0.93	0.98	0.90	0.95
7. PNSE9 [a]	0.95	0.98	0.98	0.98
8. PNSE2 [c]	0.93	0.98	0.95	0.98
9. PNSE19 [r]	0.85	0.90	0.98	0.95
10. PNSE3 [c]	0.98	0.98	0.95	0.98
11. PNSE4 [c]	0.95	0.98	0.93	0.98
12. PNSE10 [a]	0.93	0.90	0.95	0.90
13. PNSE20 [r]	0.80	0.75	0.70	0.68
14. PNSE11 [a]	0.90	0.93	0.93	0.95
15. PNSE12 [a]	0.95	0.95	0.93	0.95
16. PNSE13 [a]	0.88	0.90	0.95	0.98
17. PNSE14 [a]	0.73	0.95	0.90	0.95
18. PNSE5 [c]	0.95	0.90	0.90	0.98
19. PNSE21 [r]	0.85	0.90	0.90	0.90
20. PNSE15 [a]	0.93	0.90	0.88	0.98
21. PNSE6 [c]	0.95	0.95	0.98	0.95
22. PNSE22 [r]	0.85	0.75	0.93	0.95

Note: [a] Letters in parentheses identify the latent construct that each item was originally written to measure. [b] The statistical significance of each *V* coefficient was obtained by using the right-tailed binomial probability table provided in Aiken (1985). *V*-coefficients ≥ .70 were statistically significant at $p < .05$. *V* coefficients ≥ .78 were statistically significant at $p < .01$. Aiken (1985) only provides approximate probability values for *V* coefficients.

Table 1-8.

Mean Content-Relevance Scores and Mean-Difference Effect Sizes for Expert Judges' Ratings

Item[a]	Mean Construct Ratings						Effect Sizes for Planned Mean Contrasts[b]	
	Competence		Autonomy		Relatedness		Contrast 1	Contrast 2
	M	R	M	R	M	R		
1. PNSE16 [r]	1.18	2	1.15	1	4.68	3	r-c (3.46)	r-a (3.57)
2. PNSE7 [a]	1.43	5	4.60	3	1.08	1	a-c (2.65)	a-r (4.49)
3. PNSE8 [a]	1.63	4	4.65	3	1.05	1	a-c (2.64)	a-r (5.69)
4. PNSE1 [c]	4.65	2	1.48	3	1.08	2	c-a (3.41)	c-r (7.14)
5. PNSE17 [r]	1.03	4	1.23	4	4.78	2	r-c (5.47)	r-a (4.35)
6. PNSE18 [r]	1.08	1	1.15	2	4.80	3	r-c (4.81)	r-a (7.73)
7. PNSE9 [a]	1.48	2	4.83	2	1.08	1	a-c (3.66)	a-r (7.59)
8. PNSE2 [c]	4.70	3	1.60	3	1.03	2	c-a (2.86)	c-r (8.23)
9. PNSE19 [r]	1.05	2	1.23	3	4.68	3	r-c (5.77)	r-a (4.61)
10. PNSE3 [c]	4.88	1	1.48	3	1.05	2	c-a (4.13)	c-r (8.86)
11. PNSE4 [c]	4.83	2	1.50	3	1.05	2	c-a (3.60)	c-r (6.77)
12. PNSE10 [a]	1.20	2	4.68	2	1.13	2	a-c (4.43)	a-r (4.97)
13. PNSE20 [r]	1.18	1	1.60	4	3.90	5	r-c (1.95)	r-a (1.34)
14. PNSE11 [a]	1.23	3	4.78	3	1.25	4	a-c (4.74)	a-r (3.89)
15. PNSE12 [a]	1.23	2	4.95	2	1.08	2	a-c (5.42)	a-r (6.70)
16. PNSE13 [a]	1.35	2	4.70	3	1.05	2	a-c (3.64)	a-r (5.86)
17. PNSE14 [a]	1.18	2	4.53	4	1.08	2	a-c (3.53)	a-r (4.08)
18. PNSE5 [c]	4.83	2	1.18	3	1.05	2	c-a (5.36)	c-r (4.47)
19. PNSE21 [r]	1.05	2	1.20	3	4.55	2	r-c (4.12)	r-a (3.64)
20. PNSE15 [a]	1.45	3	4.65	3	1.08	2	a-c (2.71)	a-r (5.02)
21. PNSE6 [c]	4.88	2	1.23	2	1.08	2	c-a (4.15)	c-r (5.96)
22. PNSE22 [r]	1.05	2	1.13	2	4.40	4	r-c (3.75)	r-a (3.62)

Note: [a] Letters in parentheses identify the latent construct that each item was originally written to measure. [c] = Perceived Competence; [a] = Perceived Autonomy; [r] = Perceived Relatedness. R = Range of Expert Ratings per PNSE Item.

[b] Effect Sizes (shown in parentheses) were calculated using Cohen's (1977) effect size for dependent means (d_z).

Table 1-9.

Feedback Responses Provided During Content-Relevance Assessment Per PNSE Item

Item	Number of Experts	Percentage of Total Comments
1. PNSE16 [r]	31	77.5
2. PNSE7 [a]	19	47.5
3. PNSE8 [a]	22	55.0
4. PNSE1 [c]	15	37.5
5. PNSE17 [r]	20	50.0
6. PNSE18 [r]	22	55.0
7. PNSE9 [a]	14	35.0
8. PNSE2 [c]	16	40.0
9. PNSE19 [r]	23	57.5
10. PNSE3 [c]	16	40.0
11. PNSE4 [c]	13	32.5
12. PNSE10 [a]	19	47.5
13. PNSE20 [r]	27	67.5
14. PNSE11 [a]	32	80.0
15. PNSE12 [a]	11	27.5
16. PNSE13 [a]	15	37.5
17. PNSE14 [a]	12	30.0
18. PNSE5 [c]	11	27.5
19. PNSE21 [r]	22	55.0
20. PNSE15 [a]	17	42.5
21. PNSE6 [c]	11	27.5
22. PNSE22 [r]	18	45.0

Note. Letters in parentheses identify the latent construct that each item was originally written to measure. [c] = Perceived Competence; [a] = Perceived Autonomy; [r] = Perceived Relatedness.

Table 1-10.

Mean Item Content-Representation Ratings and R-Values for PNSE Items

	Judges														
	Group 1			Group 2			Group 3			Group 4			Total Sample		
Content Domain	*M*	*SD*	*R*	*M*	*SD*	*R*	*M*	*SD*	*R*	*M*	*SD*	*R*	*M*	*SD*	R
Competence	4.70	0.48	2	4.90	0.32	1	4.60	0.52	2	4.50	0.71	2	4.68	0.53	2
Autonomy	4.50	0.71	2	4.40	0.84	3	4.03	0.67	2	4.60	0.52	2	4.45	0.68	3
Relatedness	4.30	0.68	2	4.40	0.84	3	4.20	0.63	2	4.30	0.82	3	4.30	0.72	3

Note: Ratings were done on a 5 point Likert scale ranging from (1) = "Poor Representation" to (5) = "Excellent Representation".
R = Range (highest minus lowest plus 1) evaluating item ambiguity evident amongst PNSE items on the basis of expert ratings.

Table 1-11.

Aiken's Validity Coefficients for Judges' Ratings of Content-Representation for PNSE Items

	Judges			
Content Domain	Group 1	Group 2	Group 3	Group 4
Competence	0.93	0.98	0.93	0.88
Autonomy	0.88	0.85	0.83	0.90
Relatedness	0.83	0.85	0.80	0.83

Note: The statistical significance of each *V* coefficient was obtained by using the right-tailed binomial probability table provided in Aiken (1985). *V* coefficients ≥ .78 were statistically significant at $p < .01$. Aiken (1985) only provides approximate probability values for *V* coefficients.

Table 1-12.

Expert Appraisal of Content Representation Evident in PNSE

Item	Group 1	Group 2	Group 3	Group 4	Total Sample
Yes	60	0	30	0	22.5
No	30	80	70	100	70
Missing	10	20	0	0	7.5

Note. Ratings were done on a dichotomously scored question that read "Are there additional items that you feel should be included to represent the constructs?".

Table 1-13.

Final Set of PNSE Items

PNSE – Perceived Competence

PNSE1 - I feel that I am able to complete exercises that are personally challenging
PNSE2 - I feel confident I can do even the most challenging exercises
PNSE3 - I feel confident in my ability to perform exercises that personally challenge me
PNSE4 - I feel capable of completing exercises that are challenging to me
PNSE5 - I feel like I am capable of doing even the most challenging exercises
PNSE6 - I feel good about the way I am able to complete challenging exercises

PNSE – Perceived Autonomy

PNSE7 - I feel free to exercise in my own way
PNSE8 - I feel free to make my own exercise program decisions
PNSE9 - I feel like I am in charge of my exercise program decisions
PNSE10 - I feel like I have a say in choosing the exercises that I do
PNSE11 - I feel free to choose which exercises I participate in
PNSE12 - I feel like I am the one who decides what exercises I do

PNSE – Perceived Relatedness

PNSE13 - I feel attached to my exercise companions because they accept me for who I am
PNSE14 - I feel like I share a common bond with people who are important to me when we exercise together
PNSE15 - I feel a sense of camaraderie with my exercise companions because we exercise for the same reasons
PNSE16 - I feel close to my exercise companions who appreciate how difficult exercise can be
PNSE17 - I feel connected to the people who I interact with while we exercise together
PNSE18 - I feel like I get along well with other people who I interact with while we exercise together

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Note. PNSE = Psychological Need Satisfaction in Exercise Scale

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Study 2

Psychometric Properties of the Psychological Need Satisfaction in Exercise Scale: Latent Structure and Relationships with Extant Measures

The overall purpose of this study was to examine select psychometric properties of the 18-items developed from study one that comprised the *PNSE*. Towards this end, this study sought to (a) explore the factorial composition and structure of the *PNSE*, (b) confirm the resultant measurement model in a separate sample of exercise participants, and (c) augment the validity of scores on the *PNSE* by linking the instrument with proxy measures of need satisfaction previously used in exercise settings.

To address these purposes, data were collected in two phases within this study from two separate samples. The first phase of this study examined the factor structure and composition of the *PNSE* using Exploratory Factor Analysis (EFA) procedures, while the second phase of this study tested the *PNSE* measurement model derived in phase one with a separate sample of exercise participants using Confirmatory Factor Analysis (CFA). Both phases of this study involved linking scores on the *PNSE* with different external criteria that conceptually should converge with scores on the *PNSE*. Psychometricians have extolled the virtues of treating EFA as a precursor to CFA for the purposes of instrument evaluation (Fabrigar, Wegener, & Strahan, 1999; Gerbing & Hamilton, 1996) despite a priori knowledge regarding the theoretical or empirical structure of the measurement model (Maruyama, 1998). Nevertheless, theoretical arguments played a central role in evaluating the *PNSE* measurement model in both phases of this study given that atheoretically derived scales can be misleading (Armstrong, 1967).

A number of specific hypotheses were developed to address the purposes of this study. First, it was hypothesized that the *PNSE* would be multidimensional in nature and comprised of three factors that represent the constructs of perceived competence, autonomy, and relatedness. The basis for this hypothesis was both empirically and theoretically determined. On empirical grounds, previous research has demonstrated weak-to-modest relationships between measures of need satisfaction employed in the exercise context (Kowal & Fortier, 2000; Li, 1999; Wilson et al., 2002a; 2002b). This finding suggests that while measures of perceived need satisfaction should be associated yet conceptually distinct from one another. In addition to the empirical arguments, theoretical propositions put forth by SDT contend that perceptions of competence, autonomy, and relatedness are key elements responsible for psychological growth and development (Deci & Ryan, 1985; 2002), and as such, they should form the cornerstone of a context specific measure of psychological need satisfaction. Second, it was hypothesized that scores on the *PNSE* would be more strongly associated with existing scales that purport to measure conceptually similar rather than divergent constructs.

Phase 1

The primary purpose of phase 1 was to explore the factorial composition and structure of the *PNSE* items developed in the previous study. The secondary purpose of this study was to examine relationships between scores derived from the *PNSE* and perceived competence, locus of causality for exercise, and social motives that served as proxy measures of psychological need satisfaction.

Method

Participants

A total of 426 participants drawn from six undergraduate classes focusing on health education, movement science, or physical education provided data for this phase of study 2. At the time of data collection, all participants were in the 10th week of a semester long academic class offered during the fall term at a large urban university located in Western Canada. Participants did not receive credit towards their degree for participation in this study.

Measures

Psychological Need Satisfaction in Exercise (PNSE). Participants completed the 18-item *PNSE* developed in study 1 as a measure of psychological need satisfaction specific to exercise contexts. A stem statement (i.e., "The following statements represent different feelings people have when they exercise. Please answer the following questions by considering how you typically feel while you are exercising.") was developed that encouraged participants to respond to each question in terms of how they usually felt while exercising. Participants responded to each *PNSE* item on response foils adopted from previous self-perception measures (Marsh, 1997) with the specific anchors being (1) "False", (2) "Mostly False", (3) "More False than True", (4) "More True than False", (5) "Mostly True", and (6) "True". Sample items characterizing each *PNSE* construct included: (a) "I feel that I am able to complete exercises that are personally challenging" (*PNSE-Perceived Competence*; 6 items); (b) "I feel free to choose which exercises I participate in" (*PNSE-Perceived Autonomy*; 6 items); and (c) "I feel attached to my exercise companions because they accept me for who I am" (*PNSE-Perceived Relatedness*; 6 items).

Competence. Participants completed a modified 6-item version of the perceived competence subscale adapted from Ryan's (1982) Intrinsic Motivation Inventory (*IMI-C*). The inventory was modified to be specific to the context of exercise in a manner consistent with previous exercise psychology research using adaptations of the scale (McAuley, Duncan, & Tammen, 1989; Markland & Hardy, 1997; Markland, 1999; Whitehead & Corbin, 1991). Following the stem ("The following statements concern your thoughts about exercise. Please circle the number that indicates how strongly you agree or disagree with each of the following statements"), participants responded to each item on a 7-point Likert scale anchored at the extremes by (1) "Strongly Disagree" and (7) "Strongly Agree". Sample items reflecting the construct of perceived competence included "I think I am pretty good at exercise" and "I am pretty skilled at exercise". Previous research using the *IMI-C* with adult exercise participants suggests that greater scores on this subscale are associated with more exercise participation (Oman & McAuley, 1993) and greater intrinsic motivation (Markland & Hardy, 1997; Markland, 1999). Internal consistency reliability estimates in previous studies using this instrument have exceeded .80 (Cronbach's α's = .81 and .83 respectively; Markland, 1999; Markland & Hardy, 1997). A perceived competence score was calculated by averaging the 6 items comprising the subscale following the reverse scoring of one negatively phrased item.

Autonomy. Participants completed the Locus of Causality for Exercise Scale (*LOCE*) as a proxy measure of perceived autonomy in exercise settings. The *LOCE* is a 3-item self-report scale designed to assess the degree to which people feel that their exercise behavior is self-determined and engaged in freely rather than controlled by external contingencies (Markland & Hardy, 1997; Markland, 1999). Following the same stem as the *IMI-C* items, participants responded to each *LOCE* item on a 7-point Likert scale anchored at the extremes by (1) "Strongly Disagree" and (7) "Strongly Agree". Sample items reflecting the construct of perceived *LOCE* included "Having to exercise is a bit of a bind but it has to be done" and "I exercise because I like to rather than because I feel I have to". Previous research using the *LOCE* with adult exercise participants suggests that greater scores on this measure are associated with more intrinsic motivation (Markland & Hardy, 1997; Markland, 1999), greater perceived competence for exercise (Markland, 1999), and supports the internal consistency reliability of the *LOCE* (Cronbach's α's ranged from .73 (Rose et al. 2001) to .87 (Markland, 1999) in adult samples). An *LOCE* score was calculated by averaging the 3 items comprising the subscale after reverse coding both the negatively phrased items.

Relatedness. Participants completed the Social Motives subscale of the revised Motivation for Physical Activity (*MPAMR-S*) questionnaire (Ryan et al., 1997) as a proxy index of perceived relatedness in exercise. The *MPAMR-S* is a self-report scale assessing the degree to which specific categories of socially relevant goals motivate physical activity participation (Ryan et al., 1997) and conceptually can be considered to "reflect the need for relatedness" (Frederick-Racascino, 2002, p.287). Following a stem, ("The following is a list of reasons why people exercise. Keeping in mind your primary exercise activity, please indicate how true each reason is for you on the scale provided."), participants responded to each item on a 7-point Likert scale anchored at the extremes by (1) "Not at all true" and (7) "Very true". Sample items reflecting the construct of social motives included "I exercise because I want to be with my friends" and "I exercise because I like to be with others who are interested in this activity". Previous research using the *MPAMR-S* suggests that greater scores on this subscale are associated with exercise adherence and greater post-exercise enjoyment levels (Ryan et al., 1997) and enhanced perceptions of relatedness in exercise contexts (Wilson et al., 2002). Internal consistency reliability estimates in adult samples have exceeded .80 in previous studies using this subscale of the *MPAMR* (Ryan et al., 1997; Wilson et al., 2002b). The 4 items were averaged and summed to form an overall *MPAMR-S* score.

Procedures

Participants in this study were asked to complete a series of self-reported questionnaires (see descriptions in *Measures* section above). All participants completed the demographic questions first. The presentation order of the remaining four scales (*PNSE, IMI-C, LOCE, & MPAMR-S*) was randomized across test administrations. The item order presented within each scale was also randomized using an electronically generated random numbers table to reduce the potential for order effects during test administration.

Data Collection

The data were collected towards the end of a regularly scheduled class. All participants were approached by the same investigator and invited to participate in a study examining different reasons for exercise participation. Standard instructions were given during the data collection phase of each study to reduce the potential for between groups effects associated with test administration. Participants were given the opportunity to ask questions regarding the research project prior to providing informed consent and completing the questionnaire. All of the data were entered into SPSS 11.0 by the same researcher and the raw data sheets are stored in a locked filing cabinet in a limited access lab space.

Data Analyses

Data analyses proceeded in 6 stages. First, the data were screened for missing values, discrepant responses, and outliers (> |3| SD's away from the mean on any variable) that might adversely influence the interpretation of the analysis (Pedhazur, 1997; Stevens, 2000; Tabachnick & Fidell, 2001). Second, descriptive statistics were calculated to describe the demographic characteristics of the sample. Third, the interitem correlation matrix formed by the *PNSE* items was examined to determine the suitability of the matrix for EFA procedures (Dzubian & Shirkey, 1974). Fourth, two stopping rules (Catell's Scree Plot and Kaiser-Guttman's Eigenvalues > |1.0|) were examined in association with the principal components analysis to determine the number of factors to pursue in the solution. Fifth, the *PNSE* interitem correlation matrix was subjected to a Principal Axes Factor Analysis (PAF) with the resultant pattern matrix rotated orthogonally using equamax (Saunders, 1962) and transformed obliquely using direct oblimin ($\delta = 0$; Gorsuch, 1983). Finally, bivariate correlation coefficients (Pearson *r*'s) were computed between the *PNSE* variables created as a result of the EFA and scores on the *MPAMR-S*, *LOCE*, and *IMI-C*.

Results

Preliminary Data Screening

An inspection of the data indicated that no missing values were present, no values were out of range, and only 11 cases represented extreme responses (values > |3| standard deviations away from the mean on any need satisfaction item). These participants were subsequently removed from the data set prior to conducting any further analyses. A one-way multivariate analyses of variance (MANOVA) was conducted to determine if mean response differences emerged as a function of the order in which the subscales used in this phase of study 2 were presented. A non-significant multivariate test statistic and small overall effect size were observed (Wilks $\Lambda = .98$, $F(12, 814) = 0.87$, $p = .58$, partial $\eta^2 = .01$) suggesting no differences in participant responses as a function of the presentation format associated with the data collection instrument.

Demographic Characteristics of Sample

A total of 415 male ($n = 122$; $M_{age} = 21.38$; $SD_{age} = 2.89$) and female ($n = 170$; $M_{age} = 20.59$; $SD_{age} = 3.02$) university students enrolled in undergraduate physical activity, health, and physical education classes at a large university in western Canada provided data for this study. Almost one-third of the sample ($n = 123$; 29.6% of the sample) did not provide information pertaining to gender in this phase of the study. As might be expected in a diverse array of undergraduate students, there was considerable variability surrounding both physical activity patterns and anthropometric measurements. Specifically, males and females reported Body Mass Index (BMI) values indicative of adequate health for this age cohort (Males $M_{BMI} = 24.90$; $SD_{BMI} = 3.34$; Females $M_{BMI} = 22.16$; $SD_{BMI} = 2.15$). Participants indicated that they were, on average, physically active at the time of data collection given the overall amount of self-reported exercise engaged in during the previous week (Males $M_{METS} = 62.47$; $SD_{METS} =$

41.78; Females $M_{METS} = 58.09$; $SD_{METS} = 34.27$). These values were derived from the composite score (*METS*) on the Godin Leisure Time Exercise Questionnaire (*GLTEQ*; Godin & Shepherd, 1985) and are somewhat higher than those reported in previous studies using college-aged samples (Hayes, Crocker, & Kowalski, 1999).

Independent samples *t*-tests were used to compare the degree of similarity in demographic characteristics between the present sample and those used in phase 1 of the previous study. The results indicated that there were significant differences between the samples in terms of age (t_{years} (214) = 6.95, $p < .01$; $\eta^2 = .10$) and self-reported exercise behavior (t_{mets} (214) = 2.15, $p < .01$; $\eta^2 = .02$), and no significant differences in BMI (t_{BMI} (214) = -1.67, $p > .10$; $\eta^2 = .01$). An examination of the descriptive statistics indicated that participants in this phase of study 2 were younger and engaged in more exercise per week at the time of data collection than the exercise-class participants examined in study 1.

EFA of PNSE items

Given that the *PNSE* was an exploratory instrument with no established psychometric properties, a preliminary evaluation of the interitem correlation matrix was conducted to determine its suitability for factor analysis. Based on the recommendations of Dzubian and Shirkey (1974), the results indicated that the 18 *PNSE* items are suitable for factor analytical procedures given that (a) Bartlett's test of sphericity indicated adequate interdependence among the *PNSE* items ($c^2 = 4896.74$, $p < .01$); (b) an acceptable sampling adequacy statistic was observed (*KMO* = .90); and (c) the anti-image covariance matrix approximated the desired diagonal matrix (i.e., less than 4.57 % of the off-diagonal elements exceeded .10).

Although some dispute exists regarding the appropriate sample size for the use of EFA procedures (Cattell, 1982; Comrey, 1973; Hakstein, Rogers & Cattell, 1982; Kline, 1994), the sample employed in the present study exceeded Gorsuch's (1983) recommended minimum subject-to-variable ratio of 5:1. Furthermore, psychometricians indicate that the observed subject-to-variable ratio is less concerning than the observed properties of the measured variables (Fabrigar et al., 1999; Hakstein et al., 1982) such that under good conditions (i.e., well defined factors comprising 4-5 manifest variables per latent factor and moderate-to-high (h^2 ranged from .40 to .70) communality estimates) smaller sample sizes may be acceptable. An inspection of the data presented in Table 2-1 supports the presence of good conditions among the 18 *PNSE* items given that six items defined each latent factor and moderate-to-strong communality estimates were evident.

Two stopping rules were employed to determine the number of factors to retain from the principal components analysis of the *PNSE* items. Initially, joint consideration of both Cattell's (1978) Scree Plot criterion and Kaiser-Guttman's (eigenvalues > 1.0) stopping rule were examined. Both stopping rules suggested the retention of 3-factors given that the first 3 eigenvalues exceeded $|1.0|$ ($\lambda_1 = 6.39$; $\lambda_2 = 3.84$; $\lambda_3 = 2.22$) and the next largest eigenvalue extracted from the data was substantially smaller ($\lambda_4 = 0.63$). The empirical-based stopping rules corroborate SDT's contention regarding the number of need satisfaction constructs, and therefore, three factors were extracted from the *PNSE* correlation matrix using PAF.

Item retention was based primarily on considerations involving Thurstone's (1947) principle of simple structure, factor definition (i.e., number of manifest items per latent factor), and the theoretical interpretability of the solution. A pattern coefficient of $|.30|$ served as the lower bound of item meaningfulness on each factor (see Gorsuch 1983 and Fabrigar et al., 1999) and was the primary criteria used to judge simple structure in the solution. An inspection of the rotated pattern matrix derived from the equamax procedure indicated the presence of two factorially complex items (PNSE4 and PNSE6) that cross-loaded on the factor containing the *PNSE* autonomy items (pattern coefficients for both *PNSE* items on the non-designated factor were .31 and .32 respectively). Considering the lack of simple structure evident in the orthogonal rotation, an oblique transformation was pursued using the direct oblimin procedures.

An inspection of the transformed solution (see Table 2-1) for the 18 *PNSE* items suggested the presence of an interpretable solution with each *PNSE* item exhibiting simple structure. Factor 1 accounted for 33.6% of the total variance, contained 6 items reflecting effectance and capability associated with meeting personally challenging exercises, and was labelled "Perceived Competence". Factor 2 accounted for 19.3% of the total variance, contained 6 items representing perceptions of volition, choice, and self-determination, and was labelled "Perceived Autonomy". Finally, factor 3 accounted for 10.4% of the variance, contained 6 factorially pure items representing feelings of meaningful connection to others and was subsequently labeled "Perceived Relatedness". Further inspection of the data presented in Table 2-1 indicates low-to-moderate interfactor correlations amongst the *PNSE* subscales.

Descriptive Statistics, PNSE Subscale Reliability, and Bivariate Relationships

Descriptive statistics (see Table 2-2) revealed that in general participants reported relatively high levels of need satisfaction derived from exercise. The pattern of descriptive statistics indicated that participants reported greater satisfaction of competence and autonomy needs than relatedness in exercise settings. Internal consistency reliability estimates (Cronbach Coefficient α; Cronbach, 1951) for each measure are reported along the principal diagonal in Table 2-2. The observed coefficient α values indicated no particular problems with scale reliability considering the number of items comprising each instrument or subscale.

An examination of the bivariate correlations between the study variables (see Table 2-2) revealed several interesting relationships. First, weak-to-moderate relationships were evident among *PNSE* subscales, with *PNSE-Perceived Relatedness* exhibiting a discernibly weaker pattern of associations with both *PNSE-Perceived Autonomy* and *PNSE-Perceived Competence*. Second, *PNSE-Perceived Relatedness* was most strongly associated with *MPAMR-S* and *PNSE-Perceived Competence* was most strongly associated with *IMI-C*. Finally, *PNSE-Perceived Autonomy* was not the strongest correlate of *LOCE* observed in the present study.

Summary

The purpose of phase 1 was to explore the latent dimensionality and structure of the *PNSE* items and examine the relationships between the derived *PNSE* subscales and conceptually similar constructs assessed by existing measures. The results of this study indicate that the 18 *PNSE* items displayed excellent simple structure, each latent factor was adequately defined, and the transformed solution was interpretable and consistent with SDT (Deci & Ryan, 1985; Ryan & Deci, 2002). Further support for the psychometric integrity of the scale was demonstrated through relatively high internal consistency estimates of reliability. Relationships between *PNSE* factors and external markers of perceived competence and social motives supported the study hypotheses and provided initial evidence for the validity of the scores derived from the *PNSE*.

Despite the observed psychometric credentials of the *PNSE*, it is evident on the basis of the present results that the relationships between *PNSE-Perceived Autonomy* subscale and the *LOCE* were incongruent with theoretical expectations. A closer examination of Table 2-2 indicates that the autonomy subscale of the *PNSE* was more strongly associated with the perceived competence subscale of the *IMI* than the *LOCE*. This observation is not unique to the present study given that previous research has failed to support a relationship between the *LOCE* and other autonomy-based measures in exercise contexts derived from SDT (Rose et al., 2001). One possible explanation for this unexpected finding is the lack of congruence between the psychological constructs being represented by the *PNSE-Perceived Autonomy* subscale and the *LOCE*. An examination of the item content expressed by the *LOCE* suggests that the scale only captures perceptions of internal causation (deCharms, 1968). Recent arguments forwarded by Reeve (2002) suggest that the notion of perceived autonomy is comprised not only of perceived personal causation but also of personal choice and volition that are not expressed within the item content of the *LOCE*. Consequently, the attenuated correlation coefficient between PNSE-*Perceived Autonomy* and *LOCE* observed in this study may be a result of linking conceptually similar but not analogous constructs.

An alternative explanation for the observed relationship concerns the psychometric credibility of the *LOCE*. Since the *LOCE* was initially developed and validated primarily on female aerobics participants from the United Kingdom (Markland & Hardy, 1997), the available data attesting to the construct validity of the *LOCE* is limited. Research using the *LOCE* by Markland and Hardy indicates that the 90% confidence interval surrounding the Root Mean Square Error of Approximation (RMSEA) exceeded acceptable limits in the cross-validation analyses of the instrument (Markland & Hardy reported a 90% Confidence Interval around the RMSEA point estimate ranging from .00 to .14 in their second study). Given the importance of perceptions of causality to SDT, it would seem prudent for further research to consider the psychometric integrity of the *LOCE* prior to adopting that scale as a measure of perceived autonomy in the exercise. Irrespective of these contentions, future research should use the *LOCE* cautiously before additional psychometric tests of the instrument determine the suitability of the scale for examining theoretical propositions drawn from SDT.

Phase 2

The primary purpose of phase 2 was to test the *PNSE* measurement model derived from phase 1. This test was made by conducting a CFA on responses to the *PNSE* collected from a separate sample of exercise participants. In addition to testing the veracity of the

PNSE measurement model, additional analyses were conducted to determine the degree to which the *PNSE* is invariant across gender. Measurement invariance refers to the extent to which a measure or construct retains equivalent meaning across different conditions such as between various groups or over time (Byrne, 1998; Cheung & Rensvold, 2002; Hoyle & Smith, 1994; Vandenberg & Lance, 2000). The issue of invariance is critical to the evaluation of the *PNSE* at this stage of the scale's development given that self-referent psychological measures seem particularly sensitivity to gender (Eklund, Whitehead & Welk, 1997), and issues of invariance are important if an instrument is to be used to make meaningful group-based comparisons (Hoyle & Smith, 1994). A gender-invariant instrument would create interpretational problems in comparative analyses given that the researcher would be unable to discern if the observed effect was attributable to a true difference or merely a function of the measurement properties of the instrument (Cheung & Rensvold, 2002; Hoyle & Smith, 1994). The secondary purpose of phase 2 was to extend the construct validity evidence associated with the *PNSE* by further examining of the relationship between scores on each *PNSE* subscale and different proxy need satisfaction measures assessing perceived choice and affiliation.

Methods

Participants

A total of 581 participants drawn from seven undergraduate classes focusing on health education, movement science, or physical education provided data for this phase of study 2. At the time of data collection, all participants were in the 10th week of a semester long academic class offered during the winter term at a large urban university located in Western Canada. Participants did not receive credit towards their degree for participation in this study.

Measures

Psychological Need Satisfaction in Exercise (PNSE). Participants completed the same version of the *PNSE* used in phase 1 of this study. Subscale scores were calculated by averaging the relevant items *PNSE* items per construct.

Competence. Participants completed the same measure of perceived competence (*IMI-C*) as employed in phase 1 of this study. A perceived competence score was calculated by averaging the 6 items comprising the subscale following the reverse scoring of one negatively phrased item.

Autonomy. Participants completed an adapted version of the perceived choice subscale of the Intrinsic Motivation Inventory (*IMI-PC*) as a proxy measure of perceived autonomy in exercise settings. The *IMI-PC* is a 7-item self-report scale designed to assess the degree to which people perceive choice over their exercise behavior and decisions (Markland & Hardy, 1997; Whitehead & Corbin, 1991). Following the same stem as the *IMI-C*, participants responded to each *IMI-PC* item on a 7-point Likert scale anchored at the extremes by (1) “Strongly Disagree” and (7) “Strongly Agree”. Sample items reflecting the construct of perceived choice included “I believe I have some choice about doing exercise” and “I exercise because I want to”. Previous research using modifications of the *IMI-PC* in physical activity settings indicate that higher scores predict more intrinsically motivated behavior (Ferra-Caja & Weiss, 2000; Oman & McAuley, 1993), and report internal consistency estimates that exceed .70 (Ferra-Caja & Weiss reported Coefficient α values of .73 and .75 in males and females respectively). An overall score was calculated by averaging the seven *IMI-PC* items after reverse coding the five negatively phrased items.

Relatedness. Participants completed the 4-item Affiliation (*EMI-A*) subscale of the Exercise Motivation Inventory-2 (*EMI-2*; Markland & Hardy, 1993) as a proxy index of perceived relatedness in exercise settings. The *EMI-A* is one of 14 subscales that comprise the

EMI-2 and assesses the degree to which social aspects of the exercise such as having fun and being socially involved with other people motivate participation (Markland & Hardy, 1993; Markland & Ingeldew, 1997). Following a stem that anchored the items as reasons why people currently or potentially undertake exercise participation ("The following is a list of reasons people commonly give when asked why they are currently exercising or why they would choose to exercise. Personally, I exercise (or might exercise)…"), participants responded to each item on a 6-point Likert scale anchored at the extremes by (0) "Not at all true for me" and (5) "Very true for me". Sample items reflecting the construct of affiliation as measured by the *EMI-A* included "to enjoy the social aspects of exercising" and "to have fun being active with other people". Previous research using the *EMI-A* suggests that greater scores on this subscale are associated with higher intrinsic motivation for exercise participation (Markland & Hardy, 1993), report satisfactory internal consistency reliability estimates (Cronbach's α's ranged from .81 to .91; Ingeldew & Sullivan, 2002; Markland & Hardy, 1993; Markland & Ingledew, 1997) and stability coefficients (Pearson $r = .71$ over a 4 to 5 week period; Markland & Hardy, 1993). The 4 items were averaged and summed to form an overall *EMI-A* score.

Procedures

Participants in this study were asked to complete a series of self-reported questionnaires (see description in *Measures* section above). All participants completed the demographic questions first and two of the same measures from phase 1 of this study (the *PNSE* and *IMI-C*) along with two different proxy measures of perceived autonomy (*IMI-PC*) and relatedness (*EMI-A*). The presentation order of the remaining four multi-item scales (*PNSE, IMI-C, IMI-PC, & EMI-A*) was randomized across test administrations. The item order presented within each scale was also randomized using an electronically generated random numbers table to reduce the potential for order effects during test administration.

Data Collection

The data collection for this phase of study 2 was identical to the procedures described in phase 1. All of the data were entered into SPSS 11.0 by same researcher and analysed using this software program and AMOS 4.0 (Arbuckle, 1997). The raw data was stored in a locked filing cabinet in a limited access facility.

Data Analyses

Data analysis proceeded in sequential stages. First, the data were screened to identify potential outliers, missing values, or discrepancies that could adversely influence the subsequent analysis. Second, demographic data were analysed to describe the sample in this phase of study 2. Third, relevant descriptive statistics were calculated for the *PNSE* items to select an appropriate estimator for the CFA. Fourth, a series of CFA's were conducted to examine the fit of an oblique first order measurement model in the total sample, male and female subsamples. Fifth, sequential multigroup covariance analyses were conducted to examine the invariance of the *PNSE* measurement model over male and female subsamples. Conventional standards were specified in all CFA models evaluating both the *PNSE* measurement model and the sequential multigroup analyses across gender. Specifically, items were loaded exclusively on relevant factors, factors were allowed to correlate, error terms were not free to correlate, and the variance of each latent factor was fixed at 1.0 to define the scale for each latent variable. The final stage of the analyses involved calculating descriptive statistics and reliability estimates for the *PNSE* and proxy measures of need satisfaction, as well as, calculating the relationships between these subscale scores.

Model fit criteria. Based on previous recommendations (Hoyle & Panter, 1995; Kelloway, 1998), a number of indices were used to evaluate model fit in the CFA analyses and to empirically test the adequacy of competing models posited to underlie the PNSE responses (Cudeck & Browne, 1983). The χ^2 statistic was reported given that it provides the basis for statistical tests associated with the lack of fit resulting from overidentifying restrictions placed on the specified model. The χ^2 statistic was not used interpretively in the evaluation of model fit however given that this index is highly sensitive to sample size and minor deviations between the observed data and the specific model that have limited practical utility (Anderson & Gerbing, 1988; Hoyle & Panter, 1995).

The Incremental Fit Index (*IFI*) represents the improvement in overall fit per degree of freedom for the target model relative to the baseline model, while the Comparative Fit Index (*CFI*) estimates the relative reduction in lack of fit estimated by referencing the noncentral χ^2 of the target model to the baseline model. The *IFI* and *CFI* were chosen as preferred indicators given that previous research suggests these indices perform well with ML estimation procedures that use small samples (Chueng & Rensvold, 2002; Vanenberg & Lance, 2000; West, Finch, & Curran, 1995). The Root Mean Square Error of Approximation (*RMSEA*) was examined to assess the discrepancy between the implied and observed correlation matrices, and the Expected Cross-Validation Index (*ECVI*) was reported for the correlated PNSE measurement model. Smaller *ECVI* indices are desirable given that they indicate the extent to which the proposed measurement model is likely to replicate in cross-validation analyses (Cudeck & Browne, 1983; Ullman, 2001). Ideally, an adequate model would be one that maximized the global model fit indices (for the *IFI* and *CFI* respectively) and minimized the *RMSEA* and *ECVI* values (Cudeck & Browne, 1983).

Based on the previous recommendations (James, Mulaik, & Brett, 1982; Vanenberg & Lance, 2000), a number of indicators were examined to assess model fit in the invariance analyses given (a) there demonstrated ability to distinguish between "well" and "poor" fitting measurement models, (b) the sensitivity of various global model fit indices to the particular invariance hypothesis under scrutiny, and (c) the range of aspects of model fit represented by the indicators. Although historically measurement invariance has been tested using the Likelihood Ratio statistic (the chi-square difference test (χ^2_d) and associated difference in degrees of freedom (df_d), recent research and commentary suggests that an over reliance on this estimate of model fit may result in premature or erroneous conclusions regarding the tenability of invariance based hypotheses in model fit assessment (Chueng & Rensvold, 2002; Vandenberg & Lance, 2000). Therefore, in accordance with the recommendations of Vandenberg and Lance (2000), the decisions regarding measurement invariance associated with the *PNSE* were based on an examination of both (a) absolute fit indices ($\Delta\chi^2_d$, *Root Mean Square Error of Approximation [RMSEA]*, and *Standardized Root Mean Square Residual [SRMR]*) and (b) incremental fit indices (*Parsimony Normed Fit Index [PNFI]*, and *ΔComparative Fit Index [CFI]*). Marsh (1993) and James et al. (1982) contend that more constrained models (i.e., a model with more equality constraints) should demonstrate higher *PNFI* values compared with their less constrained (i.e., unrestricted or baseline models) counterparts. Furthermore, Cheung and Rensvold (2002) argued that changes in observed *CFI* values associated with successively more constrained models should not exceed -.001 for the demonstration of measurement invariance.

Although there is some dispute regarding the criteria indicative of acceptable model fit (Hu & Bentler, 1999), as well as, the behavior of global fit indices under various conditions (Thompson, 2000; Vandenberg & Lance, 2000), *IFI* and *CFI* values exceeding .90 and .95 are typically taken to reflect acceptable and excellent fits of the model to the data (Hoyle & Panter, 1995; Hu & Bentler, 1999) while *RMSEA* values of less than .05 and .08 in conjunction with *SRMR* values of .08 and .10 may be regarded as the boundaries of excellent and acceptable fit respectively (Cudeck & Browne, 1983; Hu & Bentler, 1999; Vandenberg & Lance, 2000).

Results

Preliminary Data Screening

Prior to conducting the main analyses, the data were inspected for missing values and outliers that could unduly influence subsequent analyses. An inspection of the demographic data indicated that no missing data was evident on any variable other than the global METS score that contained two missing values. An inspection of the responses to the *PNSE* and proxy measures of need satisfaction indicated that less than 5% of the data was missing on any one item across these measures. No discernible pattern was evident in the missing data, therefore, the mean imputation procedures suggested by Tabachnick and Fidell (2001) were used to replace the missing values in this study. The imputed values were calculated by averaging the scored items available per subscale for each participant. An inspection of the full data set indicated that no particular problems were evident on the basis of extreme responses (i.e., > |3| SD away from the mean on any one variable). Consistent with the results from phase 1 of this study, a one-way MANOVA resulted in a non-significant multivariate test statistic and small overall effect size (Wilks $\Lambda = .97$, $F(12, 500) = 0.67$, $p = .78$, partial $\eta^2 = .02$) suggesting no differences in participant responses as a function of the presentation format of the instrument.

Demographic Characteristics of Sample

A total of 223 male ($M_{age} = 22.03$; $SD_{age} = 4.16$) and 358 female ($M_{age} = 21.55$; $SD_{age} = 3.87$) university students enrolled in undergraduate physical activity, health, and physical education classes at a large university in western Canada provided data for this phase of study 2. Consistent with phase 1 of this study, considerable variability was evident in terms of both physical activity patterns and anthropometric measurements. Specifically, males and females reported Body Mass Index (BMI) values approximating health-related guidelines for this age cohort (Males $M_{BMI} = 25.01$; $SD_{BMI} = 3.28$; Females $M_{BMI} = 22.17$; $SD_{BMI} = 3.16$). Furthermore, the participants reported relatively high levels of physically activity participation at the time of data collection given the self-reported frequency of exercise involvement during the week preceding data collection (Males $M_{METS} = 65.64$; $SD_{METS} = 37.09$; Females $M_{METS} = 57.37$; $SD_{METS} = 35.00$). These self-reported exercise scores were obtained from the global exercise indicator derived from the Godin Leisure Time Exercise Questionnaire (*GLTEQ*; Godin & Shepherd, 1985).

Analysis of Variance (ANOVA) followed by Scheffe's post-hoc comparisons were used to compare the demographic characteristics of participants in this phase of study 2 with those from the previous phase and study 1. The results indicated that there were significant differences between the samples in terms of age (F_{age} (2, 642) = 39.08, $p < .01$; $\eta^2 = .11$), self-reported exercise behavior (F_{mets} (2, 642) = 5.06, $p < .01$; $\eta^2 = .02$), and BMI (F_{BMI} (2, 642) = 6.72, $p < .01$; $\eta^2 = .02$). An examination of the descriptive statistics indicated that participants in both phases of study 2 were younger than those in phase 1. Furthermore, the participants in this phase of study 2 reported lower BMI values than those in phase 1, and greater participation in regular exercise then those participants in study 1.

Item Level Descriptive Statistics for PNSE.

Table 2-3 presents the descriptive statistics for each *PNSE* item. Overall, there appear to be no grave concerns pertaining to the *PNSE* distributional properties for the total sample (*M* skewness across *PNSE* items = -1.18; *M* kurtosis across *PNSE* items = 1.67), the male subsample (*M* skewness across *PNSE* items = -1.22; *M* kurtosis across *PNSE* items = 1.71), or the female subsample (*M* skewness across *PNSE* items = -1.18; *M* kurtosis across *PNSE* items = 1.67) although departures from univariate normality are evident in the data. However, notable multivariate kurtosis was suggested on the basis of values for Mardia's (1970) coefficient in the data provided by the total sample (Mardia's coefficient = 294.41), male subsample (Mardia's coefficient = 219.83), and female subsample (Mardia's coefficient = 255.33). Although alternative estimation procedures have been suggested for nonnormal data, they typically require large sample sizes (Hu & Bentler, 1995), and have been associated with less desirable estimates of model fit when the sample size is small (Maruyama, 1998) as is the case in the present investigation. West et al. (1995) recommended the use of normal theory estimators (i.e., Maximum Likelihood) in conjunction with the *CFI* and *IFI* when the sample size is small. Therefore, maximum likelihood (*ML*) estimation procedures were employed for these analyses.

CFA of PNSE Measurement Models

Indices of global model fit derived from the CFA are presented in Table 2-4 for the correlated *PNSE* measurement model across the total sample, male, and female subsamples respectively. Not surprisingly, the correlated first-order factor model was significantly different from the independence model, however, this is hardly surprising given the sensitivity of the χ^2 statistic to sample size (Cudeck & Browne, 1983). The global indices of model fit are of greater interest for this particular study and more informative regarding the tenability of model fit. Across these indices, there appears to be a consistent pattern of support suggesting that the correlated first-order factor model provides a satisfactory fit to the data.

The standardized parameter loadings and error variances are listed for the correlated first-order model in Table 2-5 for the total sample and gender-specific subsamples. All factor loadings were statistically significant ($p < .001$), and all manifest items loaded strongly and in the specified direction on their designated latent factors with average factor loadings of .82 for the total sample (range = .73 to .89), .83 (range = .72 to .89) for the male subsample, and .82 (range = .69 to .90) for the female subsample. Examination of the distribution of standardized residuals (*z*) suggested minimal evidence of over- or under-estimation of fitted correlations (total sample: 83.01% < |2.0|; 6.54% > |3.0|; female subsample: 88.98% < |2.0|; 2.61% > |3.0|; male subsample: 94.77% < |2.0|; 0.65% > |3.0|). Consistent with the desirable indices of global model fit, uniformly strong standardized item loadings, and the satisfactory distribution of standardized residuals, it seems reasonable to suggest some support for the hypothesized 3-factor oblique measurement model underlying *PNSE* responses.

Notwithstanding these observations, a modification index (Lagrange Multiplier Test) was examined to determine if model fit could be improved without compromising the theoretical underpinnings of the *PNSE*. The pattern of modification indices across both the total sample and female subsample indicated that the largest improvement in model fit was associated with correlating the error terms between *PNSE-Perceived* Competence items 2 ("I feel confident I can do even the most challenging exercises") and 5 ("I feel like I am capable of doing even the most challenging exercises"). Although these indices suggested that the overall fit of the *PNSE* measurement model could be improved by freeing the relevant parameters, the post-hoc nature of within-factor correlated error terms in cross-sectional research has been called into question (Gerbing & Anderson, 1984). Furthermore, measurement experts contend that freeing model parameters for estimation solely on the basis of the observed modification indices is a questionable practice given that such an approach capitalizes heavily on chance relationships that fail to appropriately consider theoretical arguments (Byrne, 1998; Gerbing & Anderson, 1984; MacCallum, Roznowski, & Necowitz, 1992). Given that the changes suggests by the modification indices were minimal and not defensible on either theoretical or methodological grounds, they were not pursued further in the present investigation.

Sequential Multigroup Covariance Analysis by Gender

Despite the desirable fit of the *PNSE* measurement model in both the total sample and male and females subsamples, these CFA's did not empirically test the equivalence of *PNSE* responses across gender. Consequently, Simultaneous Multigroup Covariance Analyses (*SMCA*) were conducted following the multisample procedures advocated by Joreskog and Sorbom (1989) to assess the degree to which the *PNSE* is sensitive to gender. *SMCA* involve imposing constraints on a model's parameters in an increasingly restrictive fashion and evaluating the resultant changes in model fit. A noticeable decrement in model fit following the imposition of an equality constraint within a model is evidence of invariance across groups for the model parameter(s) being tested (Chueng & Rensvold, 2002; James et al., 1982; Vandenberg & Lance, 2000). Given that the behavior of global fit indices can be distorted when subsamples examined in *SMCA* differ in size (Vanenberg & Lance, 2000), the decision was made to have equal sample sizes for men and women respectively across the two subsamples. To attain sample size equality, 135 females were randomly deleted from the sample of female respondents that provided data for the CFA such that the invariance tests were performed on equivalent numbers of male and female participants (n = 223 in both instances).

Four specific hypotheses (equality of factor loadings, equality of factor covariances, equality of factor variances, and equality of error variances) were tested in a progressive sequential order with each hypotheses assuming support for the previous hypothesized constraint within the measurement model. The results of the multigroup invariance analysis are presented in Table 2-6. Initial examination of the χ^2_d test suggests that only model B (equality of factor loadings) is tenable across male and female subsamples. However, a closer inspection of the change in global fit values suggests minimal deterioration in model fit across models A through C thereby providing some support for the equivalence of factor loadings and factor covariances across gender for the *PNSE*. Despite these observations, it is difficult to suggest that there is even partial support for the equivalence of factor variances and error variances associated with the *PNSE* given the decrements in model fit observed across these more constrained models evidenced by the large change in *CFI* values and less desirable indices of model fit associated with the *SRMR*. Notwithstanding these observations, the equality of error variances is considered a somewhat restrictive test of measurement invariance that is rarely observed in practice (Byrne, 1998; Vandenberg & Lance, 2000) and the tests of model fit associated with the invariance hypotheses may have been affected by violations of normality present in these data. Although the results of the invariance analyses are not unambiguous, it does seem that joint consideration of all relevant fit indicators suggest that the *PNSE* is not overly sensitive to gender.

Descriptive Statistics, Scale Reliability, and Relationships Between Psychological Variables

Participants in this phase of study 2 reported greater satisfaction of the psychological needs for competence and autonomy than relatedness in exercise settings (see Table 2-7). All internal consistency reliability estimates (Cronbach's Coefficient α; Cronbach, 1951) exceeded .75 for the scales measuring psychological variables (reliability coefficients are reported along the principal diagonal of Table 2-7). Pearson correlation coefficients (see Table 2-7) indicated that *PNSE-Perceived Competence* correlates most strongly with *IMI-C* scores, and PNS-Relatedness was most strongly associated with *EMI-A* scores. Interestingly, *PNSE-Perceived Autonomy* scores were more strongly correlated with *IMI-PC* scores, although the magnitude of this relationship was not as discernible as the validity coefficients associated with the other *PNSE* subscales and their corresponding proxy measures.

Summary

The purpose of phase 2 was to confirm the tenability of the *PNSE* measurement model derived in phase 1 of this study, and to link scores on each *PNSE* subscales with additional measures of perceived choice and affiliation in an attempt to support the scale's psychometric properties. The results of both the CFA and SMCA corroborate the EFA from phase 1 of this study and revealed that the oblique 3-factor measurement model is partially invariant across gender. Further analyses examining the relationships exhibited by the *PNSE* subscales and external markers of competence and relatedness suggest additional support for the degree of validity ascribed to *PNSE* scores. In conjunction with the desirable pattern of results form the CFA in this phase of study 2, the internal consistency reliability estimates derived from the sample corroborate those displayed in phase 1 and provide additional support for the reliability of *PNSE* subscale scores. Collectively, the results of phase 2 supported the measurement model and subscales reliability associated with the *PNSE*, and suggest that the *PNSE* appears to measure perceptions of psychological need satisfaction in the context of exercise settings in accordance with SDT (Deci & Ryan, 1985; 2002).

Consistent with the results of phase 1, the results of phase 2 do not support a clear relationship between the autonomy subscale of the *PNSE* and a different proxy measure of autonomy represented by the *IMI-PC*. The bivariate correlations presented in Table 2-7 revealed that the *IMI-PC* correlated more strongly with the *PNSE-Perceived Autonomy* subscale than any of the other *PNSE* subscales. However, the magnitude of this relationship compared with those exhibited by *PNSE-Perceived Competence* and *PNSE-Perceived Relatedness* subscales with the *IMI-C* and *EMI-A* respectively was markedly reduced. Stated differently, clear evidence exists supporting the convergent validity of the *PNSE-Perceived Competence* and *PNSE-Perceived Relatedness* subscales on the basis of their relationship with external markers of conceptually similar constructs. A similar pattern of evidence was not observed in the present phase of study 2 for the *PNSE-Perceived Autonomy* subscale. It is acknowledged, however, that perceptions of choice are not synonymous with autonomy and these interpretations should be tempered with caution since a benchmark indicator of perceived autonomy is difficult to determine (Reeve, 2002; Sheldon, 2002).

Study 2 – General Discussion

The purpose of this study was to examine the psychometric properties of the newly formed *PNSE* with specific reference to the factorial structure and composition of the instrument, the internal consistency reliability of the *PNSE* subscales, the degree of sensitivity of *PNSE* scores to gender, and the relationship between scores on the *PNSE* with conceptually similar constructs. Overall, the results of this study are encouraging and suggest that the PNSE demonstrates some desirable psychometric properties across two separate samples. The results of phase 1 suggested that the *PNSE* contains a set of 18 factorially pure items that represent three latent factors which were interpretable within the framework of SDT and accounted for a substantial portion of the *PNSE* item variance (63.23%). The results of phase 2 provided additional support for the 3-factor measurement model underpinning *PNSE* responses and the invariance of the instrument across gender. The results of both phases 1 and 2 indicated each *PNSE* subscale demonstrates high internal consistency reliability indices, and the *PNSE-Perceived Competence* and *PNSE-Perceived Relatedness* subscales correlate strongly with external markers of conceptually similar constructs. Overall, both phases of this study indicated that the *PNSE* may be a useful instrument for examining psychological need satisfaction in exercise from an SDT perspective.

Factorial Structure and Composition of the PNSE

The results of phases 1 and 2 supported the theoretically derived factor structure and composition of the PNSE. Collectively, the results of both the EFA and CFA conducted in separate samples across this study suggested that the *PNSE* is a congeneric measure whereby each item measures a single latent construct (Joreskog, 1971). Psychometricians contend that instruments that exhibit congeneric properties are desirable given that such instruments are well-defined according to the number of manifest items per latent factor and allow for the most unambiguous assessment of meaning to the latent construct (Anderson & Gerbing, 1988).

In addition to the support for the 3-factor measurement model derived in phase 1 of this study, the results of the SMCA conducted on the male and female subsamples indicated that the *PNSE* is largely insensitive to gender. The lack of invariance associated with factor loadings and factor covariances exhibited by the *PNSE* across male and female subsamples provides preliminary support for the tenability of the instrument for assessing psychological need satisfaction in exercise across gender. Furthermore, the indices of model fit exhibited by the most constrained models that held both factor variances and error variances equivalent across gender did not demonstrate completely unacceptable fit according to conventional standards (Chueng & Rensvold, 2002; Hu & Bentler, 1999; Vandenberg & Lance, 2000). The demonstration of invariance at this stage of the *PNSE*'s development is encouraging and allows researchers to conduct meaningful group-based comparisons between men and women without concerning themselves with artificial differences contaminating the data as a result of differential item interpretation.

The results of both phase 1 and 2 of this study provided initial discriminant validity evidence in favour of the *PNSE* in two ways. First, an examination of the interfactor correlations reported from the EFA in phase 1 suggest that although the latent *PNSE* factors are associated with one another, there is a certain degree of conceptual and empirical independence evidenced by the low to moderate interfactor correlations (interfactor correlations ranged from .01 to -.33 respectively). Second, the phase 2 analyses provided additional support for the discriminant validity of the *PNSE* scales give that the confidence intervals surrounding each interfactor correlation failed to include 1.0 in all instances providing additional support for the empirical distinctions between these subscales.

Despite these encouraging results, the application of CFA methods in phase 2 of this study did highlight a potential weakness associated with the instrument that future research may wish to explore further. An examination of the modification indices associated with the CFA in phase 2 suggested that correlating the error terms of two of the *PNSE* items representing perceptions of competence would have substantially improved model fit. Although these modifications were not pursued, the observed modification index does suggest room for improvement within the current version of the *PNSE*. One interpretation of the suggested modifications observed in the CFA is the presence of residual variance between the manifest items that is unexplained by the *PNSE-Perceived Competence* factor and could necessitate the inclusion of additional factor (Gerbing & Anderson, 1984). Although an inspection of the item content indicates considerable overlap between these *PNSE-Perceived Competence* items, no additional factors were included given that theoretical arguments do not support the multidimensionality of perceived competence from the perspective of SDT. The pursuit of such a solution, therefore, would have favoured capitalizing on chance relationships evident in the data that are not advocated by psychometricians (Anderson & Gerbing, 1988; Byrne, 1998; MacCallum, Roznowski, & Necowitz, 1992). Consequently, it seems prudent to recognise the suggested modifications observed in the present study pertaining to the *PNSE-Perceived Competence* items, and examine the suitability of these indicators in future applications of the *PNSE*.

Relationships Between PNSE and Conceptual Markers of Need Satisfaction

The pattern of relationships exhibited by the *PNSE* subscales with proxy markers of need satisfaction used in both phase 1 and 2 of this study provide convergent evidence in support of the construct validity of score interpretations derived form the *PNSE-Perceived*

Competence and *PNSE-Perceived Relatedness* subscales. A discernible pattern of relationships was evident in both phases of this study with *PNSE-Perceived Competence* correlating most strongly with the *IMI-C* scores, and the *PNSE-Perceived Relatedness* scores correlating most strongly with the *EMI-A* and *MPAMR-S* scores respectively. Although larger correlations were observed for all competence based measures in phases 1 and 2, the observed values between *PNSE-Perceived Relatedness* and both *EMI-A* and *MPAMR-S* were somewhat lower than might be anticipated and considerably lower than those observed for the perceived competence variables. Despite this observation, neither the *EMI-A* nor the *MPAMR-S* were originally developed to measure relatedness in exercise, and the size of the relationships exhibited by the *PNSE-Perceived Relatedness* subscale with both the *EMI-A* and *MPAMR-S* is consistent with previous research (Wilson et al., 2002b) thereby supporting the convergence of scale scores on this construct.

Despite the encouraging results of phases 1 and 2 in this study, the available evidence supporting the construct validity of the *PNSE-Perceived Autonomy* subscale is weak at best. In phase 1 of this study, the scores on *PNSE-Perceived Autonomy* correlated more strongly with an external measure of perceived competence (*IMI-C*) than an external measure of autonomy (*LOCE*), although this difference was small it is contrary to the original hypotheses. The results of phase 2 suggested that *PNSE-Perceived Autonomy* is the strongest correlate of the proxy measure of perceived choice (*IMI-PC*), the magnitude of the relationship is quite weak in nature and does not provide strong evidence in favour of the construct validity of score interpretations derived form the *PNSE-Perceived Autonomy* subscale. One possible explanation for these aberrant findings is the relatively low internal consistency estimates observed for *LOCE* in phase 1 ($\alpha = .73$) and *IMI-PC* in phase 2 ($\alpha = .78$) which may have attenuated the true value of the correlation coefficients between these variables and scores on the *PNSE-Perceived Autonomy* subscale. To further investigate this possibility, two separate CFA measurement models were examined and phi (ϕ) coefficients calculated to reduce the effect of measurement error on the magnitude of the relationship between the *PNSE-Perceived Autonomy*, *IMI-PC*, and *LOCE* factors. One measurement model contained the *PNSE-Perceived Autonomy* and *LOCE* variables while the other measurement mode contained the *PNSE-Perceived Autonomy* and *IMI-PC* variables. The results of these CFA analyses offer little support for the unreliability hypothesis given that small phi coefficients were observed amongst the latent factors considered in this model ($\phi_{\text{PNSE-Autonomy.LOCE}} = .32$; $\phi_{\text{PNSE-Autonomy.IMI-PC}} = .33$).

Two possible alternative explanations for the observed relationships between *PNSE-Perceived Autonomy* and the proxy markers of psychological need satisfaction represented by *LOCE* and *IMI-PC* can be offered. From a conceptual standpoint, it is conceivable that the weak relationships were attributable to a lack of full content representation on behalf of the *LOCE* and *IMI-PC*. Recent research and commentary by Reeve (2002) investigating the "experience" of autonomy in education contends that the construct is comprised of perceptions of volition, internal locus of causality, and personal choice. Considering Reeve's contentions more carefully within the context of the present study, it seems that the magnitude of the relationships exhibited by the *PNSE-Perceived Autonomy* subscale with both the *LOCE* and *IMI-PC* might have been expected given that the latter two instruments only capture a small portion of what it means to be truly autonomous in an exercise context.

An alternative methodological explanation for the present findings concerns the presence of methods effects in both the *LOCE* and *IMI-PC* measures due to the inclusion of positive and negatively phrased items within the same scale. A growing body of research now indicates that the use of items with reverse polarity within the same scale can produce undesirable methods effects which in turn could attenuate the observed relationships between the variables under study (Motl & DiStefano, 2002; Motl, Conroy & Horan, 2000). Both the *LOCE* and the *IMI-PC* contain more negatively than positively phrased items, and the descriptive statistics associated with the negatively phrased items in both phases of this study indicated that over 34% of the respondents scored above the theoretical midpoint (i.e., |4.0|) of the scale on one of the negatively phrased *LOCE* items ("Having to exercise is a bit of a bind but it has to be done") and two of the *IMI-PC* items ("I exercise because I have to" and "I feel like I have to exercise") suggesting that respondents were strongly endorsing items with reversed polarity. Although definitive conclusions on this matter await further research, the accumulation of evidence highlighting the insidious effects of positive and negative item wording within the same scale suggests that this explanation cannot be ruled out for the *LOCE* and *IMI-PC*.

Limitations and Summary

Although the results of this study are noteworthy and theoretically meaningful, a number of limitations should be acknowledged and future research directions identified. First, the sample providing data for the present investigation was restricted to young, physically active, university-based students. Consequently, the degree to which the *PNSE* will be useful for examining psychological need satisfaction in other exercise cohorts (e.g., elderly, symptomatic) is unknown and awaits further investigation and replication using more sophisticated sampling procedures. Second, both phases of this study relied on self-report data. Psychometricians have indicated that the reliance on a single type of data can be misleading due to the influence of shared variance attributable to common methods effects (Campbell & Fiske, 1959; Marsh & Grayson, 1995). Future research should use either objective indicators of conceptually relevant constructs or need satisfaction that are relevant to the exercise context and employ multitrait-multimethod procedures (Campbell & Fiske,

1959) to tease out the possibility of contamination associated with common methods variance. Finally, both phases of this study used cross-sectional designs that limited the range of psychometric issues examined in the present study. Consistent with calls from a number of theoreticians (Frederick-Recascino, 2002; Sheldon, 2002; Sheldon & Elliot, 1999), future research using the *PNSE* should use longitudinal designs to address various psychometric issues such as stability and invariance over time that would enhance the degree of construct validity evidence attributable to scores derived from the *PNSE*.

In summary, the purpose of this study was to examine select psychometric properties associated with the *PNSE* in a sample of male and female exercisers. The results of phase 1 and 2 of this study provide preliminary evidence in support of the *PNSE*'s factor structure, the internal consistency reliability of each *PNSE* subscale, the invariance of *PNSE* scores across gender, and the presence of theoretically expected relationships between external markers of need satisfaction and the *PNSE-Perceived Competence* and *PNSE-Perceived Relatedness* subscales in particular. Furthermore, the results of phase 1 and 2 question the utility of the *LOCE* and *IMI-PC* as measures of perceived autonomy, however, it should be recognised that a psychometric evaluation of these instruments was not the main focus of the present study. Collectively, the findings from both phases of this study suggest that the *PNSE* is a promising instrument from which questions regarding the role of psychological need satisfaction in exercise contexts can be pursued within the framework of SDT (Deci & Ryan, 1985; 2002).

Table 2-1.

Items Means, Standard Deviations, Communalities, and Pattern Coefficients of the 3-Factor Direct Oblimin ($\delta = 0$) Solution of the PNSE

PNSE Item Numbers and abbreviations	*M*	*SD*	h^2	*I*	*II*	*III*
PNSE – Perceived Competence						
PNSE2 - confident I can do challenging exercise	5.09	.89	.64	**.83**	-.00	.00
PNSE5 - capable of doing challenging exercises	5.25	.87	.66	**.80**	-.00	.17
PNSE4 - capable of completing exercise challenges	5.45	.71	.75	**.83**	-.00	-.01
PNSE1 - able complete personal exercise challenge	5.43	.73	.57	**.72**	.01	.00
PNSE3 - confident in my ability to exercise	5.47	.69	.66	**.75**	.00	.16
PNSE6 - feel good about ability to exercise	5.46	.73	.58	**.66**	.10	.21
PNSE – Perceived Autonomy						
PNSE11 - free to choose exercises I participate in	5.55	.66	.65	.01	**.80**	-.01
PNSE10 - have a say in choosing exercises I do	5.51	.73	.63	.00	**.81**	-.00
PNSE9 - I am in charge of my exercise program	5.45	.72	.67	-.00	**.80**	-.01
PNSE12 - I decide what exercises I do	5.33	.75	.55	-.00	**.74**	-.00
PNSE8 - free to make my own exercise decisions	5.48	.72	.62	-00	**.77**	-.01
PNSE7 - free to exercise in my own way	5.49	.71	.53	.01	**.64**	-.17
PNSE – Perceived Relatedness						
PNSE17 - connected to people I interact with	4.66	1.17	.69	.00	.00	**.87**
PNSE14 - share a common bond with people	4.45	1.26	.58	.00	.01	**.78**
PNSE16 - close to my exercise companions	4.55	1.20	.60	-.01	-.01	**.78**
PNSE15 - sense of camaraderie with companions	4.53	1.20	.54	.00	-.00	**.75**
PNSE18 - get along with people I interact with	4.89	1.05	.60	-.01	.01	**.75**
PNSE13 - attached to exercise companions	4.37	1.38	.53	-.01	.00	**.73**

Note. Pattern coefficients in bold represent primary factor loadings of the 18 *PNSE* items retained in the final solution. Interfactor correlations were as follows: (a) $r_{I,II}$ = .47; (b) $r_{I,III}$ = .18; (c) $r_{II,III}$ = .01. h^2 = Communality estimates for each *PNSE* item.

Table 2-2.

Descriptive Statistics, Reliability Estimates, and Bivariate Correlations Between PNSE, MPAMR-S, LOCE, and IMI-C subscale scores

Variables	1		2		3		4		5		6	
	M	*SD*	*M*	*D*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
	5.	0.65	5.50	0.59	4.57	0.99	5.79	0.73	5.03	1.24	3.39	1.42
1. PNSE-Perceived Competence	.91											
2. PNSE-Perceived Autonomy	.46		.91									
3. PNSE-Perceived Relatedness	.18		.09		.90							
4. IMI-Perceived Competence	.62		.29		.20		.78					
5. LOCE	.28		.26		.14		.39		.73			
6. MPAMR – Social Motives	.07		-.09		.45		.14		.11		.82	

Note. *PNSE* = Psychological Need Satisfaction in Exercise; *MPAMR* = Motivation for Physical Activity Measure Revised – Social Motives subscale; *LOCE* = Locus of Causality for Exercise Scale; *IMI* = Intrinsic Motivation Inventory –Perceived Competence subscale. All r's > .12 statistically significant (two-tailed) at $p < .01$. Skewness values ranged from −1.48 to 0.12. Kurtosis values ranged from −0.62 to 4.74. Internal consistency reliability estimates (Cronbach's α; Cronbach, 1951) are placed along the principal diagonal.

Table 2-3.

Distributional Characteristics of PNSE Items used in CFA

	Female Sample				*Male Subsample*				*Total Subsample*			
Items	*M*	*SD*	*Skew.*	*Kurt.*	*M*	*SD*	*Skew*	*Kurt.*	*M*	*SD*	*Skew.*	*Kurt.*
PNSE – Perceived Competence												
PNSE2	4.76	1.04	-0.81	0.63	5.16	0.94	-1.21	1.67	4.77	1.06	-0.81	0.60
PNSE5	4.92	1.01	-0.90	0.59	5.21	0.94	-1.39	2.39	4.91	1.03	-0.95	0.75
PNSE4	5.23	0.87	-1.25	2.12	5.31	0.91	-1.65	3.83	5.18	0.92	-1.33	2.57
PNSE1	5.23	0.78	-0.81	0.17	5.36	0.85	-1.45	2.86	5.19	0.83	-0.97	1.11
PNSE3	5.18	0.91	-1.22	1.78	5.34	0.89	-1.52	2.61	5.14	0.95	-1.19	1.59
PNSE6	5.21	0.94	-1.47	2.91	5.32	0.89	-1.49	2.84	5.15	0.98	-1.36	2.40
PNSE – Perceived Autonomy												
PNSE11	5.32	0.95	-1.66	2.93	4.95	1.13	-1.53	2.48	5.40	0.88	-1.61	2.77
PNSE10	5.33	0.94	-2.07	5.55	4.91	1.13	-1.52	2.25	5.42	0.86	-1.83	4.02
PNSE9	5.25	0.96	-1.64	3.42	4.79	1.20	-1.37	1.46	5.37	0.87	-1.53	2.53
PNSE12	5.34	0.94	-1.92	4.58	4.96	1.12	-1.64	2.98	5.42	0.87	-1.81	3.89
PNSE8	5.29	0.95	-1.60	3.24	4.76	1.24	-1.42	1.83	5.42	0.82	-1.58	2.77
PNSE7	5.32	0.96	-1.91	4.48	4.91	1.14	-1.26	1.51	5.42	0.88	-1.64	3.13
PNSE – Perceived Relatedness												
PNSE17	4.44	1.32	-0.74	0.07	4.46	1.19	-0.57	-0.02	4.44	1.29	-0.72	0.17
PNSE14	4.42	1.28	-0.69	-0.01	4.51	1.24	-0.87	0.44	4.43	1.28	-0.76	0.14
PNSE16	4.35	1.30	-0.78	0.15	4.48	1.21	-0.61	0.22	4.38	1.28	-0.75	0.26
PNSE15	4.21	1.36	-0.61	-0.09	4.36	1.36	-0.76	0.01	4.24	1.36	-0.67	-0.06
PNSE18	4.71	1.18	-1.07	1.19	4.58	1.15	-0.81	0.89	4.69	1.17	-1.02	1.28
PNSE13	4.30	1.46	-0.79	-0.11	4.40	1.24	-0.96	0.51	4.32	1.42	-0.86	0.12

Note. *Skew.* = Univariate Skewness Values. *Kurt.* = Univariate Kurtosis Values. *PNSE* = Psychological Need Satisfaction in Exercise Questionnaire.

Table 2-4.

Indices of Global Model Fit for PNSE Measurement Models

Model Fit Indices	*Total Sample* ($N = 587$)	*Male Subsample* ($n = 229$)	*Female Subsample* ($n = 356$)
χ^2	688.03	406.53	489.59
df	132	132	132
Q	5.21	3.08	3.71
CFI	.94	.92	.93
IFI	.94	.92	.93
RMSEA	.09	.09	.08
90% *CI* for *RMSEA*	.08 - .09	.08 - .11	.07 - .09
ECVI	1.31	2.13	1.60
90% *CI* for *ECVI*	1.17 – 1.45	1.88 – 2.41	1.42 – 1.61

Note. $Q = \chi^2/df$; *CFI* = Comparative Fit Index; *IFI* = Incremental Fit Index; *RMSEA* = Root Mean Square Error of Approximation; *CI* = Confidence Interval for relevant point estimates; *ECVI* = Expected Cross Validation Index.

Table 2-5.

Standardized Factor Loadings and Error Variances for the Correlated First-Order PNSE Measurement Model

	Total		Male Subsample		Female Subsample	
	FL	*EV*	*FL*	*EV*	*FL*	*EV*
PNSE – Perceived Competence						
PNSE2	.73	.30	.79	.26	.69	.32
PNSE5	.80	.39	.84	.26	.77	.45
PNSE4	.87	.20	.87	.19	.86	.21
PNSE1	.87	.19	.88	.20	.88	.17
PNSE3	.86	.25	.87	.21	.85	.28
PNSE6	.75	.37	.80	.29	.72	.43
PNSE – Perceived Autonomy						
PNSE11	.77	.33	.80	.31	.75	.34
PNSE10	.86	.22	.87	.25	.85	.19
PNSE9	.86	.22	.89	.21	.83	.23
PNSE12	.88	.18	.87	.22	.89	.16
PNSE8	.87	.19	.87	.22	.88	.17
PNSE7	.88	.22	.80	.34	.90	.14
PNSE – Perceived Relatedness						
PNSE17	.74	.90	.72	.90	.75	.92
PNSE14	.83	.49	.82	.49	.84	.48
PNSE16	.73	.57	.76	.43	.72	.67
PNSE15	.81	.63	.81	.60	.81	.63
PNSE18	.79	.56	.76	.57	.82	.56
PNSE13	.89	.33	.88	.28	.89	.35

Note. *FL* = Standardized Factor Loading. *EV* = Error Variance. *PNSE* = Psychological Need Satisfaction in Exercise Scale. *PNSE* = Psychological Need Satisfaction in Exercise Scale. Phi (ϕ) Coefficients for the Total Sample ($\phi_{pcomp.paut} = .71$; $\phi_{pcomp.prel} = .39$; $\phi_{paut.prel} = .29$), male subsample ($\phi_{pcomp.paut} = .83$; $\phi_{pcomp.prel} = .51$; $\phi_{paut.prel} = .37$), and female subsample ($\phi_{pcomp.paut} = .65$; $\phi_{pcomp.prel} = .31$; $\phi_{paut.prel} = .26$).

Table 2-6.

Sequential Multigroup Covariance Analyses to Test Equality of Factor Structures Over Male and Female Subsamples (n = 223)

Hypothesis	χ^2	*df*	*Q*	χ^2_d	df_d	*p*	*CFI*	*ΔCFI*	*PNFI*	*SRMR*	*RMSEA (90% CI)*
Model A	741.87	264	2.81	-	-	-	.93	-	.78	.06	.06 (.058 - .069)
Model B	763.53	279	2.74	21.66	15	>.05	.93	-.001	.82	.07	.06 (.057 - .068)
Model C	774.87	282	2.75	11.34	18	< .01	.93	-.001	.82	.10	.06 (.057 - .068)
Model D	790.89	285	2.78	16.03	21	< .01	.93	-.002	.83	.11	.06 (.058 - .068)
Model E	854.56	303	2.82	63.67	39	< .01	.92	-.007	.88	.11	.06 (.059 - .069)

Note. A = Baseline (unrestricted) model
B = assuming A, testing for equivalence of factor loadings (2-factor correlated model)
C = assuming B, testing for equivalence of factor covariances (2-factor correlated model)
D = assuming C, testing for equivalence of factor variances (2-factor correlated model)
E = assuming D, testing for equivalence of error variances (2-factor correlated model)

Table 2-7.

Descriptive Statistics, Reliability Estimates, and Bivariate Correlations Between PNSE Subscales and Conceptually Relevant Constructs

Variables	1		2		3		4		5		6	
	M	*SD*	*M*	*D*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
	5.	0.68	5.54	0.60	4.48	1.07	5.72	0.82	5.51	0.94	2.40	1.32
1. PNSE- Perceived Competence	.91											
2. PNSE-Perceived Autonomy	.46		.91									
3. PNSE-Perceived Relatedness	.25		.10		.90							
4. IMI-Perceived Competence	.65		.30		.27		.82					
5. IMI-Perceived Choice	.23		.32		.05		.31		.78			
6. EMI-Affiliation	.06		-.01		.48		.07		-.09.		.92	

Note. *PNSE* = Psychological Need Satisfaction in Exercise; *EMI* = Exercise Motivation Inventory; *IMI* = Intrinsic Motivation Inventory. All *r*'s > .05 significant at $p < .05$ (two-tailed). All *r*'s > .10 significant at $p < .01$ (two-tailed). Skewness values ranged from −1.55 to −0.14. Kurtosis values ranged from −0.69 to 2.39. Internal consistency reliability estimates (Cronbach's Coefficient α; Cronbach, 1951) are placed along the principal diagonal.

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Study 3

The Relationships Between Psychological Need Satisfaction, Exercise Regulations, and Motivational Consequences

The main purpose of this study was to evaluate SDT's (Deci & Ryan, 1985; 2002) contention that perceptions of psychological need satisfaction play a pivotal role in the development and expression of more self-determined forms of behavioural regulation in exercise contexts. To accomplish this purpose, data were collected in two phases from two separate samples of university-based exercise participants to determine (a) the multivariate relationships between global perceptions of psychological need satisfaction, exercise regulations, and select motivational consequences, and (b) the relationship between perceptions of competence, autonomy, and relatedness with both controlled (external and introjected) and self-determined (identified and intrinsic) exercise regulations. A secondary purpose of this study was to explore the relationship between changes in perceived psychological need satisfaction and exercise regulations over the course of a 10-week period in people participating in self-selected exercise classes.

To accomplish these purposes, the following study was conducted in two phases. The first phase of this study examined the relationship between global perceptions of need satisfaction, exercise motives that span the regulatory continuum, and select motivational consequences. Drawing from previous research and theoretical arguments (Deci & Ryan, 1985; 2002; Mullan & Markland, 1997; Wilson et al., 2002a), it was hypothesized that (a) greater overall need satisfaction would be more positively associated with self-determined forms of exercise motivation (identified and intrinsic exercise regulations), and (b) self-determined exercise regulations would predict more positive motivational consequences. The second phase of this study focused on the relationship between perceived need satisfaction and exercise regulations that span SDT's motivational continuum. For phase 2, it was hypothesized that greater satisfaction of competence, autonomy, and relatedness needs would be associated with more self-determined forms of exercise motivation exemplified by identified and intrinsic regulations. Second, it was hypothesized that increases in perceived need satisfaction over time would be associated with greater endorsement of more self-determined as opposed to controlling (external and introjected) forms of exercise regulation. Support for this hypothesis would corroborate SDT's assertion that accumulated experiences that facilitate need satisfaction within a given domain promote the internalization of behavioural regulation (Deci & Ryan, 1985; 2002; Ryan, 1995).

Phase 1

The purpose of phase 1 was to examine a portion of the motivational model proposed by Vallerand and Losier (1999) that draws heavily on propositions put forth by SDT (Deci & Ryan 1985; 2002). According to Vallerand and Losier, motivational consequences (namely behavior, cognition, and affect) are underpinned by different regulations that in turn are nurtured by the degree of perceived need satisfaction derived from a given context. For the purposes of the present investigation, desirable motivational consequences were represented by greater frequency of exercise behavior, positive attitudes towards exercise, and less frequently reported negative affect usually associated with exercise involvement.

Method

Participants

A total of 175 participants drawn from a university activity program provided data for this phase of study 3. At the time of data collection, all participants were members of a team enrolled in an all-night physical activity competition sponsored by the intramural program at a large university in western Canada.

Measures

Perceived Psychological Need Satisfaction in Exercise Scale (PNSE). Participants completed the same version of the *PNSE* used in study 2. Subscale scores were calculated by averaging the relevant items *PNSE* items per construct

Behavioural Regulation in Exercise Questionnaire (BREQ). The *BREQ* is a 15 item self-report measure developed to assess the exercise regulations comprising SDT's motivational continuum (Mullan et al., 1997). The *BREQ* contains 4 subscales that measure external, introjected, identified, and intrinsic regulation of exercise behavior. Sample items characterizing each *BREQ* subscale are: "I exercise because other people say I should" (*External Regulation*; 4 items); "I feel guilty when I don't exercise (*Introjected Regulation*; 3 items); "I value the benefits of exercise (*Identified Regulation*; 4 items); and "I enjoy my exercise sessions" (*Intrinsic Regulation*; 4 items). Following the stem, "Why do you exercise?", participants responded to each item on a 5-point Likert scale anchored at the extremes by (0) "Not true for me" and (4) "Very true for me". Previous research has supported the *BREQ*'s multidimensional factor structure (Wilson et al., 2002a), the internal consistency reliability of each *BREQ* subscale (Cronbach's α's exceeded .70; Mullan et al., 1997), invariance across sex (Mullan et al., 1997), and the ability of *BREQ* scores to discriminate between physically active and non-active groups (Mullan & Markland, 1997) and exercisers possessing high and low physical self-esteem (Wilson & Rodgers, 2002).

Negative Affect Schedule (NAS). Participants completed five items as an index of the degree of negative affect typically experienced in exercise. These items were drawn from the short form of the Positive Affect Negative Affect Schedule as an index of perceived negative affect typically associated with exercise participation. Participants responded to each item on a 5-point Likert scale anchored at the extremes by (1) "Very slightly or not at all" and (5) "Extremely". Previous research suggests that the short form of the *NAS* is factorially distinct from other affect constructs, less burdensome to respondents than the longer version of the instrument, and invariant across age (Mackinnon et al., 1999). The five *NAS* items were averaged to form a subscale scale.

Attitudes Towards Exercise (ATE). Participants completed 3 items drawn from previous exercise psychology research that tapped the *instrumental* component of attitudes as a measure of exercise-related cognition (Rhodes, Courneya, & Hayduk, 2002; Rhodes, Courneya & Jones, 2002; Rhodes, Jones, & Courneya, 2002). Following a stem that contextualized the items ("For me, exercising regularly is…"), participants responded to each item on a 9-point bipolar scale. The specific item pairs were as follows: (a) Foolish-Wise; (b) Useless-Useful; and (c) Harmful-Beneficial. Previous research indicates that the *ATE* is factorially distinct from other facets of attitude and exhibits satisfactory internal consistency reliability estimates (Coefficient α's > .80 in university-based samples, Rhodes et al., 2002). The 3 *ATE* items were averaged to form an overall attitude towards exercise score.

Exercise Behavior (ExB). Participants completed a modified version of the LTEQ (Godin & Shepherd, 1985) comprised of 3 self-report items assessing the frequency of mild, moderate, and strenuous exercise done for at least 20 min per session during a typical week. A total exercise score can be calculated by weighting, then summing, each frequency dimension by its associated MET value (a unit representing the metabolic equivalent of physical activity in multiples of resting oxygen consumption) using the following equation: ([strenuous x 9] + [moderate x 5] + [mild x 3]). Previous research has demonstrated that the LTEQ is easy to understand, responsive to changes in exercise behavior, and demonstrates anticipated relationships with scores derived from physical activity monitors and maximal fitness tests (Cardinal, 1996; Jacobs, Ainsworth, Hartman, & Leon, 1993). Each individual item was weighted by the relevant MET value and then summed to form a composite exercise behavior score (METS) for use in subsequent analyses in this study.

Procedures

Participants in this study were asked to complete a series of self-report questionnaires (see description in *Measures* section above). All participants completed the same demographic questions used in the previous studies first, followed by the psychological measures that were presented in a random order across the data collection phase of this study. The item order presented within each scale was also randomized using an electronically generated random numbers table to reduce the potential for order effects during test administration.

Data Collection

The data were collected at the outset of a structured physical activity program. All participants were approached by the same investigator and invited to participate in a study examining different reasons for exercise participation. Standard instructions were given during the data collection phase of each study to reduce the potential for between groups effects associated with test administration. Participants were given the opportunity to ask questions regarding the research project prior to providing informed consent and completing the questionnaire. Participants took approximately 15 minutes to complete the survey packet in small groups ($n < 15$). All of the data were entered into SPSS 11.0 by the same researcher and the raw data sheets are stored in a locked filing cabinet in a limited access lab space.

Data Analyses

Data analyses proceeded in four sequential stages. First, the data were screened for missing values and extreme responses. Second, descriptive statistics were calculated for demographic variables and manifest items. Third, a series of measurement models were examined to determine the suitability of the instruments employed in this sample prior to estimating the structural model. This stage included an examination of the measurement model for both the *PNSE* (oblique first order 3-factor model) and the *BREQ* (oblique first order 4-factor model), as well as, three oblique measurement models conducted separately for each motivational consequence variable that were comprised of a global need satisfaction variable, the four *BREQ* subscales, and a motivational consequence variable. Fourth, Structural Equation Modeling (SEM) procedures using Arbuckle's (1997) AMOS program were used to examine the multivariate relationships between a global index of psychological need satisfaction, exercise regulations, and motivational consequences represented by *ATE*, *NAS*, and *ExB*. A global index representing perceived psychological need satisfaction was used in this analysis since the major purpose of this phase was to examine the role of overall feelings of psychological need satisfaction in the proposed motivational model rather than the role of individual psychological need satisfaction constructs. The global index was created by treating the *PNSE* subscales as manifest items and loading them onto a latent variable to represent overall psychological need satisfaction derived from exercise contexts. For the purposes of the SEM, items were loaded exclusively on relevant factors, factors were allowed to correlate, error terms were not free to correlate, and the variance of each latent factor was fixed at 1.0 to define the scale for each latent variable. Similar conditions were specified for the measurement model analyses with the only difference being the loading of an indicator was fixed at 1.0 to define the scale for each variable. The CFA and SEM examining exercise behavior used the METS indicator as an observed variable rather than a latent variable with manifest indicators.

Results

Preliminary Data Screening

An inspection of the data indicated that no missing values were present, no values were out of range, and only responses to the aggregated METS variables deviated substantially from normality (values > |3| standard deviations away from the mean). An inspection of the METS responses (see Table 3-1) indicated that two participants provided responses that were more than |5| standard deviations away from the mean. Following the removal of these troublesome cases, the METS data were transformed using the square root transformation procedures recommended by Tabachnick and Fidell (2001) and the resultant normalized variable was more adequately distributed (*M* = 5.99; *SD* = 2.67; *Skew.* = -0.13; *Kurt.* = 0.43). This transformed variable was used in all subsequent analyses concerning exercise behaviour. Consistent with the results of study 2, a one-way MANOVA was used to determine the extent of mean response differences attributable to the presentation of the instruments in this phase of study 3. A non-significant MANOVA was observed (Wilks Λ = .86, $F(20, 324) = 1.25$, $p = .21$, partial $\eta^2 = .07$) suggesting no differences in participant responses as a function of the presentation of the instruments used in this phase of study 3.

Demographic Characteristics of the Sample

A total of 84 men ($M_{age} = 22.73$ years, *SD* = 3.51) and 91 women ($M_{age} = 22.23$ years, *SD* = 3.72) provided data for this phase of study 3. Consistent with the previous studies, participants indicated that they were somewhat physically active on a weekly basis at the time of data collection ($M_{METS} = 43.03$, *SD* = 32.97) and reported Body Mass Index (*BMI*) values approximating the healthy range for this age cohort ($M_{METS} = 22.99$ Kg/M^2, *SD* = 3.92).

Analysis of Variance (ANOVA) followed by Scheffe's post-hoc comparisons were used to compare the demographic characteristics of participants in this phase of study 3 with those from the previous phases of study 1 and 2. The results indicated that there were significant differences between the samples in terms of age (F_{age} (3, 814) = 28.35, $p < .01$; η^2 = .10) and BMI (F_{BMI} (3, 814) = 4.75, $p < .01$; $\eta^2 = .02$) but no differences in terms of self-reported exercise behavior (F_{mets} (3, 812) = 2.45, $p > .05$; $\eta^2 = .01$). An examination of the descriptive statistics indicated that participants in this phase were older than study 2's participants, and reported greater BMI values than participants involved in phase 2 of study 2.

Descriptive Statistics, Scale Reliability, and Interscale Correlations

An examination of the descriptive statistics (see Table 3-3) revealed that participants endorsed greater satisfaction of the psychological needs for competence and autonomy over relatedness in exercise, although the size of this discrepancy is reduced from those in study 2. Internal consistency reliability estimates (Cronbach's α; Cronbach, 1951) for each multi-item indicator are presented along the principal diagonal of Table 3-3 and suggest no particular problems with scale reliability given that all α's exceed .80. An inspection of the bivariate correlations between study variables (see Table 3-3) indicates a number of interesting relationships. First, moderate-to-strong correlations are evident amongst the *PNSE* subscales, and between the *PNSE* subscales and more self-determined exercise regulations measured by the *BREQ*. Second, identified and intrinsic exercise regulations are positively correlated with attitudes and behavior and negatively correlated with aversive affect usually experienced in exercise.

Selection of an Estimator

Prior to conducting the CFA and SEM analyses, the distributional properties of each manifest variable were examined for conformity with the relevant assumptions (Hayduk, 1996; Mardia, 1970). An inspection of the descriptive indices suggests no particular areas of concern regarding the *PNSE* (see Table 3-2) or *BREQ* (see Table 3-1) items (although *BREQ* item 14 [Ide1] was somewhat kurtotic in comparison to the other items).

In conjunction with the univariate distributional concerns, notable multivariate platykurtosis was evident in the data for all measurement models (Mardia's (1970) coefficients ranged from 63.51 to 186.67 across the measurement and structural models respectively). Although alternative procedures have been developed for use with data that deviate from normality, they do require large sample sizes to produce stable estimates of model fit and parameter values and tend to produce misleading results when the sample size is small (Kelloway, 1998; Maruyama, 1998). Consequently, Maximum Likelihood (*ML*) estimation was used in all CFA and SEM analyses in conjunction with the Incremental Fit Index (*IFI*) and Comparative Fit Index (*CFI*) given that these fit indices appear least susceptible to distortion when used with nonnormal data in small samples (Cheung & Rensvold, 2002; Hu & Bentler, 1999). The Root Mean Square Error of Approximation (*RMSEA*) was also reported as an index of absolute model fit. Although considerable debate exists pertaining to the selection and evaluation of model fit indicators (Hu & Bentler, 1999; Thompson, 2000; Vandenberg & Lance, 2000), values of .90 and .95 (*IFI* and *CFI*) and values of .08 and .05 (*RMSEA*) are typically considered to represent acceptable and excellent fit of the model to the data (Chueng & Rensvold, 2002; Hoyle & Panter, 1995; Hu & Bentler, 1999; Vandenberg & Lance, 2000).

CFA of Measurement Models

Consistent with the recommendations of Anderson and Gerbing (1988), a series of oblique measurement models were evaluated for the *PNSE*, *BREQ*, and three models comprising a different motivational consequence variable in each instance (*ATE*, *ExB*, *NAS*) using CFA procedures. Not surprisingly, both the *PNSE* and the *BREQ* measurement models differed significantly ($p < .001$) from the independence model. Nevertheless, an inspection of the global model fit indices provided a more positive assessment of the proposed measurement models in the present sample (see Table 3-4). Furthermore, all standardized factor loadings for both the *PNSE* model and the *BREQ* model were statistically significant ($p < .001$) and moderate-to-strong in nature (see Figure 3-1 and 3-2 respectively). The distribution of standardized residuals (z) further corroborated the adequacy of each measurement model with minimal evidence of over- or underestimation of fitted correlations for either the *PNSE* (93.46% $z < |1.0|$, 0% $z > |2.0|$) or *BREQ* (98.08% $z < |2.0|$, 0% $z > |3.0|$) respectively.

Given the high interrfactor (ϕ) coefficients evident amongst *PNSE* subscales in study 2 (ϕ coefficients ranged from .26 to .83 across male and female subsamples), three additional configurations of the *PNSE* measurement model were examined to test the discriminant validity amongst the latent *PNSE* factors. Following the recommendations of Anderson and Gerbing (1988), three nested models that constrained a different "pair" of *PNSE* ϕ coefficients in each model to 1.0 were compared with the unconstrained *PNSE* measurement model to determine if any combination of the three *PNSE* latent constructs could be reduced to a single factor. Although the fit of each nested model bordered acceptability (*Model 1* [$\phi_{comp.rel} = 1.0$] $\chi^2 = 399.75$; $p < .001$; $CFI = .90$; $\Delta CFI = -.026$; $\Delta PNFI = -.005$; $IFI = .91$; $RMSEA = .11$ [.10 - .12]; *Model 2* [$\phi_{aut.rel} = 1.0$] $\chi^2 = 377.04$; $p < .001$; $CFI = .91$; $\Delta CFI = -.018$; $\Delta PNFI = .002$; $IFI = .91$; $RMSEA = .10$ [.09 - .12]; *Model 3* [$\phi_{comp.aut} = 1.0$] $\chi^2 = 385.48$; $p < .001$; $CFI = .91$; $\Delta CFI = -.021$; $\Delta PNFI = -.001$; $IFI = .91$; $RMSEA = .10$ [.09 - .12]), the chi-square difference test for nested models supported statistically significant differences between the nested and unconstrained models examined in these analyses. Furthermore, an inspection of the change in *CFI* (Chueng & Rensvold, 2002) and *PNFI* (James et al., 1982) values suggested that the constrained models did not provide a better account of the observed data given the less than desirable reduction in *CFI* values (> -.001 in all constrained models) and no marked improvement in fit evidenced by increased *PNFI* values across more constrained models. Collectively, these data support the 3-factor oblique measurement model and provide evidence in favour of the discriminant validity of the *PNSE* subscales.

An inspection of the modification indices (Lagrange Multiplier test) suggested that alterations to the *PNSE* and *BREQ* measurement models were suggested by the data in this study. The largest improvement in model fit in the *PNSE* measurement model could be obtained by correlating the error terms associated with *PNSE*-Perceived Autonomy items 13 ("I feel free to make my own exercise program decisions") and 15 ("I feel like I am in charge of my exercise program decisions"). In the measurement model concerning the *BREQ*, the largest improvement in model fit could be obtained by estimating the relationship between the error terms associated with *BREQ*-Intrinsic Regulation item-11 ("I enjoy my exercise sessions") and *BREQ*-Identified Regulation item-14 ("I value the benefits of exercise"), although the overall magnitude of improvements suggested from these modifications was trivial. Given that the suggested modifications to both the *PNSE* and *BREQ* measurement models could not be theoretically justified, and given that the substantive meaning and practice of correlating error terms in cross-sectional research is highly questionable (Gerbing & Anderson, 1984), the changes suggested by the modification indices to both *PNSE* and *BREQ* measurement models were not pursued.

Prior to examining the predictive utility of the SEM models, the full measurement models containing *ATE*, *ExB*, and *NAS* as separate endogenous variables were tested. Each measurement model differed significantly (all p's < .001) from the independence model, however, the global indices of model fit (see Table 3-4) and distribution of standardized residuals (z) were acceptable for the measurement models concerning attitudes towards exercise (98.57% $z < |2.0|$, 0% $z > |3.0|$), exercise behaviour (98.26% $z < |2.0|$, 0% $z > |3.0|$), and negative affect (98.02% $z < |2.0|$, 0% $z > |3.0|$). In conjunction with the strong parameter loadings on their relevant latent factors, it seems reasonable to suggest that each measurement model examined in this phase demonstrated some desirable psychometric properties despite the less than optimal distributional characteristics of the motivational consequence data in the present study.

SEM Analyses Examining the Relationships Between Psychological Need Satisfaction, Exercise Regulations, and Motivational Consequences

SEM analyses were used to test the proposed models positing that exercise related cognition (*ATE*), behaviour (*ExB*), and affect (*NAS*) were a function of the exercise regulations governing participation, which in turn, were determined by the degree of psychological need satisfaction typically perceived in exercise contexts. An inspection of the global model fit indices (see Structural Model 1's presented in Table 3-4) suggested that the motivational models examined herein provided an acceptable account for the observed data. The distribution of standardized residuals (z) concerning the models containing attitudes towards exercise (83.33% $z < |2.0|$, 6.66% $> |3.0|$), exercise behaviour (92.38% $z < |2.0|$, 5.71% $> |3.0|$), and negative affect (86.96% $z < |2.0|$, 5.33% $> |3.0|$) respectively in conjunction with the moderate-to-strong factor loadings observed for each SEM analyses corroborated the tenability of the structural models under investigation[1], although the Lagrange Multiplier test consistently suggested that model fit could be improved by freeing the correlation between the disturbance terms associated with external and introjected exercise regulations.

Irrespective of these suggested modifications, the results of the SEM analyses (see Figures, 3-3, 3-4, & 3-5) indicated that global perceptions of psychological need satisfaction accounted for a small portion of the variance in both external and introjected exercise regulations, and a large portion of the identified and intrinsic exercise regulation variance across the respective models. Furthermore, exercise regulations accounted for portions of the variance in negative affect ($R^2 = .27$), exercise behaviour ($R^2 = .18$), and exercise cognition in the form of attitudes towards exercise ($R^2 = .35$) that correspond with Cohen's (1992) criteria for moderate-to-large effect sizes. An examination of the standardized path coefficients associated with each conceptual model makes it apparent that greater perceived psychological need satisfaction was associated with less external regulation, and less strongly associated with introjected regulation in comparison to the strong relationships evident between psychological need satisfaction and internalized forms of exercise motivation represented by identified and intrinsic regulations. Furthermore, an examination of the standardized path coefficients linking exercise regulations with motivational consequences revealed several interesting patterns of relationships. First, external regulation was negatively associated with attitudes towards exercise and positively associated with negative affect surrounding exercise. Second, identified regulation was the only significant predictor of exercise behavior. Finally, intrinsic exercise regulation was the strongest predictor of both exercise cognition and affect; however, the direction of the standardized path coefficients makes it apparent that more intrinsically regulated exercise participation is linked with higher instrumental attitudes for exercise and less negative affect surrounding exercise participation.

A series of additional models were examined to elaborate on the nature of the motivational processes responsible for promoting positive behavioural and psychological consequences. The additional models examined (labelled Structural Model 2's in Table 3-4) differed from the mediational models (see Figures 3-3, 3-4, & 3-5 and Structural Model 1's in Table 3-4) by specifying a direct effect of psychological need satisfaction on each motivational consequence in addition to the mediated effects posited through exercise regulations. An examination of the omnibus test statistics revealed several noteworthy findings concerning each model. First, it appears that while no observable decrement in model fit (evidenced by changes in *CFI* and *PNFI* values specifically) was evident, the direct path from global psychological need satisfaction to both exercise behavior ($\beta = .28, p = .49$) and negative affect ($\beta = -.32, p = .15$) was non-significant in both models and the overall amount of additional variance accounted for with the inclusion of this direct path was small

($\Delta\chi^2_{ExB} = 0.82$; $p > .05$; $\Delta R^2_{ExB} = .007$; $\Delta\chi^2_{NAS} = 4.15$; $p < .05$; $\Delta R^2_{NAS} = .013$). Second, the model involving exercise attitudes showed a slight improvement in fit with the inclusion of the direct path from global psychological need satisfaction to *ATE* and the amount of variance accounted for in the model increased substantially ($\Delta R^2_{ATE} = .10$). Furthermore, the standardized path coefficient linking global psychological need satisfaction with *ATE* ($\beta = .71$, $p < .01$) remained significant despite the inclusion of exercise regulations, and the comparison of the two models predicting *ATE* suggests some support for the retention of this direct effect ($\Delta\chi^2_{ATE} = 13.73$; $p < .01$).

Summary

The primary purpose of the present study was to examine a portion of the motivational model proposed by Vallerand and Losier (1999) on the basis of propositions central to SDT (Deci & Ryan, 1985; 2002) that asserts motivational consequences are a function of the regulations governing them, which in turn, are determined by the degree of need satisfaction experienced within a given context. The secondary purpose of the present study was to extend the construct validity evidence of the *PNSE* by examining a series of alternative measurement models. The results of the CFA examining both the *PNSE* and the *BREQ* measurement models supported the factorial structure and composition of each instrument. Comparison of the unconstrained *PNSE* measurement model with the constrained models derived by fixing a latent factor correlation to unity provided empirical evidence that the *PNSE* subscales are discriminant from one another from a psychometric perspective. The results of the SEM analyses provided some support for the hypothesis that motivational consequences in the form of attitudes towards exercise, exercise behaviour, and negative affect can be partly understood on the basis of the exercise regulations motivating participation. However, the available evidence does not support the fully mediated effects of exercise regulations on the relationship between global perceptions of need satisfaction and exercise attitudes. That being said, the magnitude of the effects exhibited in the present study on the basis of the amount of variance accounted for in both self-determined exercise regulations and motivational consequences does corroborate the veracity of the motivational models examined in this study.

An inspection of the standardized path coefficients (see Figures 3-3, 3-4, 3-5) makes it apparent that greater psychological need satisfaction is clearly associated with more self-determined identified and intrinsic exercise regulations. Consistent with SDT (Deci & Ryan, 1985; 2002; Ryan & Deci 2000), greater reliance on external regulation as a motivational foundation is not only associated with a reduced perception of psychological need satisfaction, but also facilitates less desirable motivational consequences in terms of reduced exercise behavior, less favourable attitudes towards exercise participation, and greater negative affect typically experienced while participating in exercise. In contrast, the results of the SEM make it apparent that intrinsic regulation is associated with the most desirable pattern of cognitive and affective motivational consequences. However, identified regulation was the only significant predictor of exercise behavior in the present sample which is somewhat inconsistent with the notion that intrinsic regulation promotes the most desirable behavioural consequences in terms of exercise involvement. Despite this theoretical inconsistency, the finding that identified regulation contributes to the most positive behavioural outcomes of motivation is in line with previous applications of SDT (Koestner & Losier, 2002; Wilson & Rodgers, in press; Wilson, Rodgers, Fraser, & Murray, in press). Although replication of this finding is warranted, it would appear that the available evidence in favour of the beneficial influence of identified regulation on adaptive forms of exercise behavior is in line with Koestner and Losier's (2002) assertion that the "commonly held beliefs about intrinsic motivation and adaptation" (p. 117) be re-examined especially in exercise where the reasons motivating engagement and persistence may not be intrinsically driven.

Phase 2

The primary purpose of phase 2 was to examine the relationship between all three psychological need satisfaction constructs and exercise regulations in participants currently enrolled in structured exercise classes. Building on the findings from the previous phase of this study, the present investigation examined the relationships between each need satisfaction construct and exercise regulations using multivariate analyses. The secondary purpose of this study was to examine the relationship between changes in need satisfaction constructs and exercise regulations over the course of 10-weeks in a self-selected exercise class.

Method

Participants

A total of 292 participants drawn from twenty-one university-based exercise provided data for this phase of study 3. At the time of the initial data collection, all participants were in the second week of a 12-week exercise class offered during the session at a large urban university located in Western Canada. The second test adm was completed 10 weeks later during the last week of the class. Each exercise class by a certified fitness instructor, lasted between 30 and 55 minutes in duration, and f predominantly on cardiovascular conditioning.

Measures

Perceived Psychological Need Satisfaction in Exercise Scale (PNSE). Participan completed the same version of the *PNSE* used in previous phases. Subscale scores were calculated by averaging the relevant items for each *PNSE* factor.

Behavioural Regulation in Exercise Questionnaire (BREQ). Participants completed the same version of the *BREQ* used in the previous phase of this study. Subscale scores were computed by averaging the relevant items for each *BREQ* construct.

Procedures

Participants in this study were asked to complete a series of self-reported questionnaires (see descriptions in *Measures* section above) on two separate occasions. All participants completed the demographic questions first. The presentation order of the *PNSE* and BREQ was randomized across test administrations. The order of survey items presented within each scale was also randomized using an electronically generated random number [illegible] normality. Second, the suitability of the full measurement model was tested through the application of CFA procedures using Arbuckle's (1997) AMOS software program. Third, the relationship between perceptions of psychological need satisfaction and exercise regulations was examined using Structural Equation Modelling (SEM) techniques advocated for the testing of psychological models (Anderson & Gerbing, 1988; MacCallum & Austin, 2000). Finally, paired samples *t*-tests, intraclass correlation coefficients (*R*), and effect size calculations (Cohen's d; Cohen, 1969) were used to provide information pertaining to the size and direction of the changes exhibited by the *PNSE* and *BREQ* over 10 weeks. [illegible] correlation coefficients were computed to evaluate the relationship between [illegible] and for both the psychological need satisfaction and exercise regulations [illegible] hierarchical regression procedures to account for initial status on a [illegible] Data [illegible] analyses of variance (MANOVA) procedures were used separately on the data at time 1 and 2 to determine if mean response differences emerged as a function of the subscale presentation order in this phase of study 3. The results of these analyses for both time 1 (Wilks Λ = .96, *F*(7, 248) = 1.48, *p* = .18, partial η^2 = .04) and time 2 (Wilks Λ = .93, *F*(7, 103) = 1.19, *p* = .31, partial η^2 = .08) data suggest no differences in participant responses as a function of the instrument presentation format.

Demographic Characteristics of Sample

more times per week) as opposed to infrequent (exercising only 1-2 times per week) exercisers based on their participation in self-reported strenuous weekly exercise.

ANOVA procedures followed by Scheffe's post-hoc comparisons were used to compare the demographic characteristics of participants in this phase of study 3 with those from phase 1 of this study, as well as, participants providing demographic data in study 1 and 2. The results indicated that there were significant differences between the samples in terms (4, 1032) = 3.72, $p < .01$; $\eta^2 = .01$), and age (F_{years} (4, 1032) = 46.49, $p < .01$; η^2 differences in terms of self-reported exercise behavior (F_{mets} (4, 1018) = 1.91, p 1). An examination of the descriptive statistics indicated that participants in this gnificantly older than any of the previous samples, and the only significant terms of BMI was between the samples used in study 2.

analyses was conducted to compare the demographic characteristics of the 115) of participants that provided data at both time points in this phase hose that only provided data at the study outset (n = 177). The results of licated that there were no significant differences in terms of age (t_{years} (288) exercise behavior (t_{mets} (277) = 1.74, $p > .08$), BMI (t_{BMI} (288) = -0.85, p sychological need satisfaction (Wilk's $\Lambda = 0.98$, F (3, 263) = 1.82, $p > .10$), tions (Wilk's $\Lambda = 0.99$, F (4, 272) = 0.84, $p > .10$). On the basis of these yses, it seems reasonable to suggest that there were no pre-existing nthropometric, or motivational differences between those participants that at both time points and those that only participated in the initial test n. Furthermore, while the overall amount of people failing to provide data he second time point is larger than desired, this number is consistent with previous research documenting a fifty-percent dropout in structured programs within the first 6 months following exercise initiation (Dishman, 1994; Sallis & Owen, 1999).

Item Level Descriptive Statistics and Selection of an Estimation Procedure

The distributional properties of the *PNSE* and *BREQ* items were examined to select a suitable estimation procedure for conducting both the CFA and SEM (see Tables 3-5 & 3-6 respectively). A number of *PNSE* and *BREQ* items exhibited large univariate skewness and kurtosis values, and substantial multivariate kurtosis was evident (Mardia's coefficient = 126.458). Data that violate assumptions of normality can produce misleading indices of model fit (such as inflated χ^2 values and modest underestimation of global model fit indices) when used with maximum likelihood (*ML*) estimation procedures (West, Finch, & Curran, 1995). However, asymptotically distribution free estimation procedures can misspecify models when used with small sample sizes (Maruyama, 1998). Consequently, ML estimation procedures were employed in the present investigation in conjunction with the Incremental Fit Index (*IFI*), Comparative Fit Index (*CFI*), and Root Mean Square Error of Approximation (*RMSEA*) to evaluate model fit given that these indices are recommended when using ML procedures in small samples with nonnormal data (Maruyama, 1998; West et al., 1995).

Although considerable debate exists pertaining to the criteria indicative of acceptable model fit in SEM analyses (Hu & Bentler, 1999; Thompson, 2000), fit indices greater than .90 or .95 (for the *CFI* and *IFI*) are typically considered indicative of acceptable and excellent model fit, whereas values less than .08 and .05 (for the *RMSEA*) respectively are considered to represent reasonable and close model fit (Thompson, 2000). Recent commentary does suggest that our understanding of the behavior of various fit indices under different conditions remains limited (Fan, Thompson, & Wang, 1999; Thompson, 2000), and that general rules-of-thumb pertaining to cut-off criteria for model fit appear questionable.

Consequently, conservative estimates of model fit (*CFI* and *IFI* values > .90 and *RMSEA* values < .08) were adopted for the evaluation of both the measurement and structural models in the present investigation.

CFA of PNSE and BREQ Measurement Models

Both the *PNSE* and *BREQ* measurement models were evaluated using CFA procedures prior to analysing the full measurement and structural models. The overall fit of the 3-factor oblique *PNSE* measurement model was deemed reasonable given the observed global model fit indices ($\chi^2 = 280.64$; $df = 132$; $p < .001$; *IFI* = .95; *CFI* = .95; *RMSEA* = .073 [90% *CI* = .061 to .085]), minimal evidence of over- and underestimation of fitted correlations in the distribution of standardized residuals (84.32% $z < |1.0|$, 0% $z > |2.0|$), and the pattern of strong standardized parameter loadings of manifest items on their intended latent factors (λ's ranged from .77 to .92; see Table 3-5 for specific values). Interfactor (ϕ) correlations ranged from .16 to .69 among the latent *PNSE* factors.

Consistent with phase 1 of this study, three nested *PNSE* measurement models were analyzed to test the discriminant validity of the *PNSE* subscales. In each model, a different phi coefficient was constrained to 1.0 to determine if the relevant pair of latent *PNSE* factors could be reduced to a single construct (Anderson & Gerbing, 1988). Although the fit of each nested model was reasonable (*Model 1* [$\phi_{comp.rel} = 1.0$] $\chi^2 = 470.673$; $p < .001$; *CFI* = .91; ΔCFI = -.029; Δ*PNFI* = -.015; *IFI* = .91; *RMSEA* = .09 [.083 - .10]; *Model 2* [$\phi_{aut.rel} = 1.0$] $\chi^2 = 471.99$; $p < .001$; *CFI* = .91; Δ*CFI* = -.040; Δ*PNFI* = -.015; *IFI* = .91; *RMSEA* = .09 [.08 - .10]; *Model 1* [$\phi_{comp.aut} = 1.0$] $\chi^2 = 469.93$; $p < .001$; *CFI* = .91; Δ*CFI* = -.039; Δ*PNFI* = -.014; *IFI* = .91; *RMSEA* = .09 [.08 - .10]), the chi-square difference test for nested models was significant ($p < .001$) in all instances suggesting each phi coefficient was significantly different from 1.0 for each nested model. Further inspection of the change in *CFI* (Chueng &

Rensvold, 2002) and *PNFI* (James et al., 1982) values did not support the retention of the more constrained nested models. On the basis of these analyses, it seems reasonable to suggest that the *PNSE* subscales are highly interrelated yet sufficiently discriminant from one another from a psychometric perspective.

The results of the CFA analysis testing the fit of the 4-factor oblique *BREQ* measurement model was also adequate given the observed global model fit indices (χ^2 = 182.432; *df* = 84; $p < .001$; *IFI* = .93; *CFI* = .93; *RMSEA* = .074 [90% *CI* = .059 to .089]), minimal evidence of over- and underestimation of fitted correlations in the distribution of standardized residuals (96.19% $z < |2.0|$, 0.95% $z > |3.0|$), and the associated pattern of moderate-to-strong standardized parameter loadings of manifest items on their intended latent factors (λ's ranged from .52 to .91; see Table 3-6 for specific values). Interfactor (ϕ) correlations ranged from -.25 to .67 and represented an ordered pattern of relationships with adjacent subscales demonstrating more positive relationships than distal subscales.

Descriptive Statistics, Scale Reliability, and Interscale Correlations

An inspection of the descriptive statistics presented in Table 3-7 indicates that competence and autonomy needs were more satisfied in exercise classes across both time 1 and 2 in the present study than relatedness needs, and identified and intrinsic exercise regulations were the most strongly endorsed motives for exercise participation. The internal consistency reliability estimates (Cronbach's α's) reported in Table 3-8 indicate no particular areas for concern although it is noted that the value reported for *BREQ*-Identified Regulation at time 2 is somewhat lower than previous research (Mullan et al., 1997; Wilson et al., 2002a). Bivariate correlations computed between the *PNSE* and *BREQ* subscales at time 1 (see Table 3-8) support weak-to-moderate interrelationships between *PNSE* constructs, and positive correlations between all three *PNSE* subscales and identified and intrinsic exercise regulations.

CFA of the Full Measurement Model

Prior to examining the structural model positing directional relationships between perceptions of psychological need satisfaction and exercise regulations, the psychometric adequacy of the full measurement model comprising seven correlated latent factors (four *BREQ* subscales and three *PNSE* subscales and their manifest indicators) was conducted using the CFA procedures recommended by Anderson and Gerbing (1988). For the purposes of evaluating the full measurement model, individual items were loaded exclusively on relevant latent factors, factors were allowed to correlate, uniquenesses were not free to correlate, and the variance of each latent factor was fixed at 1.0.

An examination of the model fit indices suggested that the full measurement model appears tenable ($\chi^2 = 857.315$; $df = 474$; $p < .001$; $IFI = .92$; $CFI = .92$; RMSEA = .062 [90% $CI = .055$ to .068]). The omnibus estimates of model fit were further corroborated by minimal evidence of over- and under-estimated fitted correlations suggested by the distribution of the standardized residuals (97.53% $z < |2.0|$, 1.89% $z > |3.0|$), and the moderate-to-strong relationships between the latent factors and manifest indicators for each latent construct contained within the full measurement model (λ's ranged from .56 to .92). Interfactor (ϕ) correlation coefficients indicated weak-to-strong (ϕ coefficients ranged from -.25 to .70) relationships among latent factors were consistent with theoretical expectations given that negative correlations were only evident between need satisfaction variables (perceived competence, autonomy, and relatedness) and controlling motives (external and introjected regulations), and between controlling and self-determined (identified and intrinsic) exercise motives.

SEM of Psychological Need Satisfaction and Exercise Regulations

A structural model based on the tenets of SDT (Deci & Ryan, 1985; 2002) that posited exercise regulations as a function of perceived psychological need satisfaction was evaluated using SEM procedures which have been advocated for testing theoretical models (MacCallum & Austin, 2000). For the purposes of the SEM analyses, manifest indicators were loaded exclusively on their respective latent factors, error variances and disturbance terms were not free to correlate, and a factor loading for each latent construct was fixed at 1.0 to define the scale.

Figure 3-6 presents the results of the SEM analyses depicting the standardized path coefficients between all latent constructs included in the structural model (distributional characteristics, standardized parameters loadings, and error variances for all manifest variables are presented in Table 3-5 for the *PNSE* and Table 3-6 for the *BREQ* respectively) Although some discrepancy existed between the proposed model and the observed data (χ^2 = 926.444; $df = 480$; $p < .001$), acceptable model fit indices were evident (*CFI* = .90; *IFI* = .91; *RMSEA* = .066 [90% *CI* = .060 to .073]) and the manifest variables loaded strongly on their intended latent factors (λ's ranged from .67 to .92). Further, minimal evidence of over- or underestimation of fitted correlations was observed in the distribution of the standardized residuals (92.63% $z < |2.0|$, 2.84% $z > |3.0|$). The satisfactory distribution of residuals was further corroborated by the observed standardized Root Mean Square Residual (*SRMR*) value for the structural model (*SRMR* =.07). In sum, the results of the omnibus measures of model fit suggested that the proposed model is tenable for the observed data.

An examination of the standardized path coefficients estimating the relationships between the exogenous *PNSE* factors and endogenous *BREQ* factors embedded within the structural model revealed several interesting patterns of relationships (see Figure 3-6). First, a pattern of moderate-to-strong phi coefficients corroborated the strength and theoretically expected direction of the relationships between *PNSE* constructs in this sample of exercise participants. Second, perceived competence was strongly linked with external, identified, and intrinsic exercise regulations respectively; however, the direction of the standardized path coefficients suggests that greater satisfaction of the psychological need for competence is associated with more self-determined exercise regulations. Third, perceived autonomy made a significant contribution to the prediction of both identified and intrinsic exercise regulations. Finally, perceptions of relatedness were significantly associated with both controlling (external) and self-determined (identified) forms of exercise regulation in the present sample when considering the joint influence of all need satisfaction constructs proposed by SDT. Overall, the structural model examined in this SEM analysis accounted for small ($R^2_{external} = .08$ and $R^2_{intrjoected} = .01$) to moderate ($R^2_{identified} = .32$ and $R^2_{intrinsic} = .36$) amounts of the exercise regulation variance in the present study.

Relationships Between Changes in Psychological Need Satisfaction and Exercise Regulation

The changes in *PNSE* and *BREQ* subscales were examined over a 10-week period using paired samples *t*-tests. Effect sizes (ES) were calculated following the within-group analysis procedures advocated by Johnson and Eagly (2000) for the estimation of ES's in repeated measures designs. While significant increases in all three *PNSE* subscales, as well as, *BREQ*-Identified and *BREQ*-Intrinsic regulations were observed over the 10-week period, the magnitude of these changes was quite small in nature (see Table 3-7). The descriptive statistics (see Table 3-7) revealed that perceived competence, autonomy, and relatedness, as well as, identified and intrinsic regulation increased over the 10-week period. Alternatively, no significant change was evident in the controlling external and introjected regulation subscales of the *BREQ*. Change scores were calculated for each *PNSE* and *BREQ* subscale by regressing the time 2 subscale score onto the corresponding time 1 subscale score for each construct and saving the residual variance as an index of the amount of estimated change associated with each psychological construct. Single-sample *t*-tests indicated that none of the transformed scores created from the regression procedures differed significantly from zero (all *p*'s < .01). Pearson correlation coefficients were calculated between the change score variables (see Table 3-9) and revealed several interesting patterns in the data that are worthy of commentary. First, interrelationships amongst *PNSE* constructs were moderate-to-strong in nature and all in a positive direction (*r*'s ranged from .32 to .50). Second, increases in all three *PNSE* construct were associated with increases in intrinsic regulation, and with the exception of *PNSE*-Perceived Relatedness, identified regulation. Third, increases in *PNSE*-Perceived Autonomy were significantly associated with decreases in *BREQ-External Regulation*.

Summary

The purpose of the phase 2 of this study was to (a) examine the relationships between each psychological need satisfaction construct posited by SDT and the regulatory continuum as measured by the *BREQ* (Mullan et al., 1997), (b) and extend the construct validity evidence of the *PNSE* by further examining the veracity of the proposed 3-factor oblique measurement model and assessing the degree to which changes in need satisfaction over time (measured by the *PNSE*) correlate with changes in *BREQ* subscale scores. The results of the SEM indicated that greater perceptions of competence and autonomy are clearly associated with more self-determined forms of exercise regulation. In line with previous research (McAuley, Pena, & Jerome, 2001), it does appear on the basis of the SEM analyses that perceived competence is the strongest psychological need-based predictor of exercise motivation. Notwithstanding this observation, the results of the SEM analyses also revealed that perceived autonomy significantly predicts self-determined exercise regulations when considered jointly with other *PNSE* constructs, while perceptions of relatedness made smaller contributions towards the prediction of both controlling and self-determined extrinsic motives. The amount of observed variance accounted for in both identified and intrinsic exercise regulations by psychological need satisfaction constructs in the SEM analyses corresponds to large effect sizes (Cohen, 1992) corroborating the tenability of the relationship between need satisfaction and optimal motivational development outlined within SDT (Deci & Ryan, 1985; 2002). Given that SDT contends satisfaction of all three psychological needs is important to personal well-being and motivational development, it is particularly encouraging to see scores derived from the newly formed *PNSE* demonstrating relationships that are in line with this theoretical premise.

In addition to the results of the SEM analyses, the results of the CFA examining both the *PNSE* and *BREQ* in this sample provided further support for the psychometric properties of these instruments for capturing both exercise-specific need satisfying experiences and motivational regulations. Internal consistency reliability estimates exhibited by the *PNSE* and *BREQ* across the samples used in both phases of this study supported the psychometric credibility of both instruments. The paired samples *t*-tests indicated that both the *PNSE* and *BREQ*-Identified and Intrinsic subscales changed over time rather than being stagnant. Moreover, the direction of the relationships exhibited between the change score variables corroborates SDT's argument that contextual support for need satisfaction facilitates the internalization of behavioural regulations.

Study 3 – General Discussion

The main purpose of study 3 was to examine the relationships between perceived psychological need satisfaction and exercise regulations. The secondary purposes were to (a) extend the psychometric evidence associated with the *PNSE* by examining the instrument's factorial integrity and sensitivity over time, and (b) examine the link between motivational consequences (namely exercise attitudes, behavior, and negative affect) and exercise regulations proposed by SDT.

Psychometric Properties of the PNSE

Consistent with the findings presented in study 2, the results of the CFA and internal consistency estimates conducted in both phases of this study provide additional support for the *PNSE* measurement model. The results of two CFA's performed on separate samples of exercise participants supported the oblique 3-factor measurement model upon which the *PNSE* was developed. Although modifications to the *PNSE* measurement model were suggested in both phases of this study, it is worth noting that the overall fit of the *PNSE* measurement model exceeded conventionally acceptable standards in each instance. Consistent with calls for repeated assessment of scale dimensionality as evidence of construct validity (Messick 1995), the results of this study support the factorial structure and composition of the *PNSE* in samples of exercise participants that vary in their demographic composition.

One consistently troubling result emerging from these initial studies is the degree of statistical overlap between *PNSE* subscales observed at both the bivariate and multivariate levels of analyses. The latent factor correlations reported from the CFA indicated that need satisfaction constructs measured by the *PNSE* are associated with one another and *PNSE-Perceived Competence* and *PNSE-Perceived Autonomy* in particular share considerable variance (ϕ coefficients ranged from .69 to .88). Although smaller relationships between *PNSE* subscales would be desirable from a psychometric standpoint, the relationships observed between *PNSE* subscales are consistent with previous research (Wilson et al., 2002a; 2002b) and support the theoretical premise that need satisfying experiences are not mutually exclusive (Deci & Ryan, 1985; 2002; Ryan, 1995; Shahar et al., 2003). No support for the nested models constraining successive phi coefficients to unity was evident in either phase of this study thereby providing some discriminant validity evidence in favour of the 3-factor *PNSE* measurement model. Nevertheless, the magnitude of the observed relationships between latent *PNSE* factors could prove troublesome in future applications of the scale in predictive analyses due to the potential for collinearity effects amongst highly correlated predictors (Licht, 1995; Pedhazur, 1997). On the basis of this observation, future research should examine the degree of collinearity in the data using the diagnostic recommendations outlined by Pedhazur (1997).

Psychological Need Satisfaction and Exercise Regulations

Consistent with the original hypotheses and theoretical arguments (Deci & Ryan, 1985; 2002; Ryan, 1995), the results of the SEM analyses indicated that greater perceptions of psychological need satisfaction derived from exercise contexts are associated with more internalized or self-determined forms of exercise regulation. The results of phase 1 in particular make it clear that overall perceptions of psychological need satisfaction predict greater endorsement of identified and intrinsic exercise regulations. The results of phase 2 revealed that perceived competence is the dominant predictor of more self-determined exercise regulations, however, perceptions of autonomy play a pivotal role in the internalization of motivational regulations that are self-determined in nature. The results of the change score analysis corroborated the importance of perceived need satisfaction to internalization given the direction of the relationships observed in Table 3-7. Moreover, increases in perceived autonomy were also associated with a decreased endorsement of external regulation, suggesting that reliance on sources of interpersonal control for exercise participation diminishes as feelings of personal ownership and volition evolve.

The findings concerning perceived competence and autonomy corroborate theoretical arguments and support previous research in a number of ways. First, it seems apparent that although overall need satisfaction is associated with more self-determined reasons for exercise motivation, perceived competence is the dominant predictor of identified and intrinsic exercise regulations. This finding is consistent with previous exercise-based research that promotes competence-based perceptions (such as self-efficacy) as a central force in exercise motivation (McAuley, Penna, & Jerome, 2001; Rodgers & Gauvin, 1998; Rodgers & Sullivan, 2000), and corroborates SDT's contention that a sense of personal competence is an important component in behavioural regulation (Deci & Ryan, 1985; 2002; Ryan, 1995). Interestingly, the results of both the bivariate and SEM analyses from the second phase of this study revealed that feeling competent is negatively associated with the least internalized form of controlling motivation (external regulation). One possible implication from this finding is that the more competent and effective a person becomes at meeting the challenges associated with exercise the less they have to rely on other people to force or encourage their participation.

In addition to the results concerning perceived competence, the results of both phase 1 and 2 of this study revealed that perceived autonomy plays a crucial role in the endorsement of self-determined exercise regulations. A closer examination of the structural effects from phase 2 indicates that perceived autonomy accounts for variation in both identified and intrinsic forms of self-determined motivation despite the contributions of both perceived competence and relatedness. Given that a major theoretical premise forwarded by SDT concerns the pivotal role of perceived autonomy and volition in psychosocial development (Deci & Ryan, 1985; 2002; Ryan, 1995; Sheldon et al., 2002), it is particularly encouraging to see scores on the *PNSE* reflect this theoretical argument in relation to an exercise specific measure of SDT's motivational continuum. The practical significance of this finding is tied to the nature and resultant effects ensuing from different forms of motivation. Given that SDT and the empirical data in this study support the beneficial effects of more self-determined exercise motives, an important practical concern involves how to promote the internalization process and encourage more self-determined forms of motivation. On the basis of the present study, it would appear that promoting both perceptions of competence and autonomy might be fruitful avenues for practitioners to explore in terms of enhancing optimal motivational development in exercise contexts.

While the findings concerning perceived competence and autonomy's relationship with the motivational continuum substantiate SDT's arguments (Deci & Ryan, 1985; 2002; Ryan, 1995), the pattern of results informing the relatedness-motivation link is less clear in comparison with the other psychological need satisfaction constructs. An examination of the results from phase 2 of this study indicated that at the multivariate level of analyses, perceived relatedness facilitates both controlling and self-determined forms of exercise motivation exemplified by external and identified regulations on the *BREQ*. From a theoretical perspective, this finding is hardly inconsistent with SDT's contention that perceived relatedness "provides the groundwork for facilitating internalization" (Ryan & Deci, 2000, p. 64) and therefore might be expected to promote both controlling and self-determined forms of exercise regulation given that people seem more amenable to regulate behavior in accordance with those they feel a connection with than those they feel isolated from in social contexts (Koestner & Losier, 2002; Shahar et al., 2003).

Given the lack of research examining perceived relatedness in the exercise domain (Frederck-Recascino, 2002), and the mixed findings associated with theoretical examinations of relatedness reported in previous research (Kowal & Fortier, 2000; Shahar et al., 2003), the results of the present investigation provide novel information pertaining to this facet of psychological need satisfaction in exercise contexts. One possible explanation for the relationships between relatedness and exercise regulations observed in the present study revolves around the exercise contexts from which the participants in this study were drawn.

Participants in phase 1 were recruited from a program in which they engaged in various "team-based" physical activities, whereas the participants in phase 2 of this study were enrolled in exercise classes with people that they could have felt a minimal degree of connection with prior to enrolment. Consistent with the findings observed in the initial phase of study 1, it seems plausible that feelings of relatedness play a less pivotal role in structured exercise contexts than was anticipated despite the socially orientated nature of this context. Future research would do well to explore this issue more carefully given that SDT contends it is the degree to which social contexts satisfy relatedness needs that is the key to successful internalization, and it is assumed that all psychological needs within SDT are inherent and universal requirements for motivational development and expression (Deci & Ryan, 1985; 2002; Ryan, 1995).

An alternative explanation for the observed relationships between perceived relatedness and exercise regulations stems from theoretical considerations surrounding the interplay between need satisfaction, internalization, and intrinsic motivation. In their recent review of internal motives, Koestner and Losier (2002) contend that "relatedness and autonomy are the two most important needs" (p. 106) warranting satisfaction for internalization, however, "the need for relatedness is not essential for intrinsic motivation" (p. 106). The data presented in this study corroborate Koestner and Losier's contentions in exercise given that perceived relatedness was not associated with intrinsic motivation in the multivariate SEM analyses (phase 2) that considered the collective influence of all need satisfaction constructs on exercise regulations. One practical implication of this finding is that intervention attempts designed to promote successful internalization could consider efforts to satisfy both relatedness and autonomy needs, however, if the ultimate goal of the intervention is to develop intrinsic motivation then a focus on both skill acquisition (perceived competence) and fostering a sense of personal choice and ownership (perceived autonomy) becomes essential. Future research may wish to examine this issue more carefully using experimental designs to determine the influence of manipulating each need satisfaction construct on both internalization and intrinsic motivation towards exercise.

Changes in Psychological Need Satisfaction and Exercise Regulations

The results of the subsample analyses revealed that the *PNSE* is sensitive to small changes in need satisfaction over a 10-week period and that changes in perceived need satisfaction are associated with less controlling external regulations and more self-determined identified and intrinsic exercise regulations. Although there is considerable debate surrounding the utility of change scores (Cronbach & Furby, 1970; Rogosa, 1995), an examination of the ES's indicated that none of the significant changes in either need satisfaction or exercise regulation indices were large. The presence of ceiling effects is probably responsible for small observed ES's and the lack of significant differences evident in the single-sample *t*-tests examining the size of the residual change variance computed from the regression procedures. In light of these observations, the conclusions regarding the relationships between changes in need satisfaction and exercise regulations should be tempered with a suitable degree of circumspection prior to replication in additional samples where troublesome ceiling effects do not constrain the data or degree of change possible over time.

Despite this cautionary note, the descriptive statistics indicated that both perceptions of need satisfaction and self-determined exercise regulations increased over time which is a finding in line with SDT's contentions regarding motivational development. Of additional interest, the direction of relationships between variables calculated from the change scores indicates that increased need satisfaction was associated with more intrinsic regulation of exercise behavior, while increases in perceived competence and autonomy in particular were positively associated with changes in identified regulation. A final noteworthy point was that greater perceptions of autonomy were associated with a reduced endorsement of external regulation indicating that changes in autonomy can precipitate changes in both controlling and self-determined forms of exercise regulation in a manner suggested by SDT (Deci & Ryan, 1985; 2002; Ryan, 1995).

Although from a psychometric perspective instability in *PNSE* and *BREQ* subscale scores indicated in Table 3-7 might seem problematic, the lengthy time frame between test administrations in this study cannot discount the possibility of true change occurring in perceived psychological need satisfaction and exercise regulation constructs. While the longer time period does reduce the potential influence of carry-over effects on test scores (Pedhazur & Schmelkin, 1991), psychometricians recommend that studies interested in examining the stability of an instrument's scores be conducted over much shorter time span (i.e., two weeks) for the purposes of estimating test-retest reliability (Crocker & Algina, 1986; Pedhazur & Schmelkin, 1991). On the basis of the available data, it seems reasonable to suggest that the *PNSE* is capable of detecting changes in need satisfaction that occur over the course of a 10-week period in exercise classes. This conclusion should be tempered with caution however until future research has determined the degree of stability (or change) associated with *PNSE* scores over shorter time periods as an index of test-retest reliability.

Regulatory Continuum and Motivational Consequences

The results of phase 1 of this study support the beneficial outcomes ensuing from more self-determined reasons for exercise participation in comparison to engaging in exercise due to a forced sense of compliance or obligation. The results of the SEM analyses from phase 1 indicated that more self-determined exercise regulations clearly predict more frequent exercise participation and more positive psychological consequences in terms of holding favourable exercise attitudes and experiencing less negative affect surrounding exercise participation. Furthermore, it appears that participation motivated by compliance with external contingencies is associated with less favourable thoughts and more negative feelings regarding exercise involvement. On the whole, this pattern of findings corroborates both theoretical arguments (Deci & Ryan, 1985; 2002; Ryan, 1995) and previous research in both exercise settings (Kowal & Fortier, 2000; Mullan & Markland, 1997; Ryan et al., 1997; Wilson et al., 2002a; Wilson & Rodgers, 2002) and other domains (Sarrazin et al., 2002; Pelletier et al., 2002; Vallerand, Fortier, & Guay, 1997) that attest to the positive effects stemming from more self-determined reasons for behavioural regulation.

The results of the SEM analyses in phase 1 provided some preliminary support for the sequence of motivational processes that influence both behavioural and psychological consequences in exercise contexts. On the basis of the standardized structural effects observed in phase 1 of this study (see Figures, 3-3, 3-4, & 3-5), it seems clear that exercise regulated by intrinsic reasons promotes the most positive pattern of psychological consequences in terms of reduced negative affect and enhanced instrumental attitudes towards exercise participation. This finding is in line with the majority of previous research that contends positive benefits result from involvement that is intrinsically regulated, due probably to the fact that no external inducement or reward is required to initiate or sustain a person's involvement.

Despite this observation, the results of the SEM analyses also revealed that identified regulation is the dominant predictor of exercise behavior when motivational influences are considered from a multivariate standpoint. In line with previous research (Wilson et al., 2002a; Wilson & Rodgers, in press), this result corroborates Ryan's (1995) contention that self-determined forms of extrinsic motivation might be particularly important for behavioural initiation or persistence in contexts where the activity itself may not be perceived as enjoyable or satisfying. Despite the theoretical appeal of this finding, it seems reasonable to acknowledge that the lack of a significant predictive relationship between intrinsic regulation and exercise behavior is likely due to shared variance (> 60%) between identified and intrinsic exercise regulations. An alternative theoretical explanation for the present findings is that the critical distinction responsible for promoting frequent exercise behavior patterns lies between controlling and self-determined forms of exercise regulation rather than between intrinsic and extrinsic motives. Following this argument, it seems reasonable to suggest that self-determined exercise regulations predict more positive behavioural consequences in the exercise domain. Future research could explore this issue further by examining the effects of exercise involvement over time that is motivated by either identified or intrinsic regulations.

Limitations and Summary

Despite the theoretical and practical appeal associated with the present findings, a number of limitations should be recognized and future research directions outlined. First, both phases of this study used convenience samples that were comprised predominantly of women enrolled in cardiovascular exercises classes that constrain the generalizability of these findings (Pedhazur & Schmelkin, 1991). Future studies should attempt to replicate these findings using different demographic cohorts and exercise modes. Second, although SDT's contention that regulations develop in contexts that satisfy psychological needs remains tenable, the causal implications of this assertion were not directly examined in the present study. Despite the findings of the SEM and subsample analyses reported in phase 2, future research using the *PNSE* in experimental designs that allow for more careful examination of this theoretical argument seem advisable. Third, this study focused exclusively on variables inherent to SDT (Deci & Ryan, 1985; 2002; Ryan, 1995) and examined a restricted array of motivational consequences. The results of both phases in this study indicate that there is considerable variance in both exercise regulations and motivational consequences left unexplained in the SEM analyses leaving considerable scope for the examination of additional variables. Future research may wish to address this issue by examining the contributions of demographic considerations (e.g., age, sex, type of exercise) and theoretical constructs (e.g., integrated exercise regulation) in determining the mechanisms responsible for both exercise regulations and motivational consequences.

In summary, the overall purpose of this study was to examine the relationship between perceptions of need satisfaction for competence, autonomy, and relatedness with behavioural regulations that span SDT's motivational continuum in exercise contexts. The results of phase 1 make it apparent that overall need satisfaction within exercise is associated with more self-determined reasons for participation, which in turn, predicts more favourable behavioural and psychological outcomes. The results of the second phase revealed that perceived competence and autonomy especially predict more self-determined reasons for exercise participation, while increases in all three need satisfaction constructs over time correlated with more intrinsic exercise regulation. Overall, the results of this investigation are promising and support Deci and Ryan's (2002) contention that perceived competence, autonomy, and relatedness represent essential "nutriments" (p. 7) that promote healthy development, engagement, and psychological well-being within a particular context. Given the importance of motivation to understanding exercise initiation and persistence issues, the study of psychological need satisfaction from the perspective of SDT in exercise contexts appears justified and further exploration of this theoretical perspective is warranted.

Table 3-1.

Distributional Characteristics of Exogenous Variables used in SEM analyses

BREQ Variables Item Abbreviations	*M*	*SD*	*Skew.*	*Kurt.*
BREQ - External Regulation (Ext)				
Ext1 – I feel pressured to exercise by friends/family	1.34	1.29	0.49	-0.89
Ext2 – exercise because others say I should	1.03	1.17	0.91	-0.09
Ext3 – exercise because others would not be pleased	0.85	1.16	1.21	0.47
Ext4 – I exercise because others say I should	0.91	1.19	1.51	0.22
BREQ - Introjected Regulation (Inj)				
Inj1 – I feel ashamed when I miss an exercise session	1.63	1.28	0.29	-1.00
Inj2 – I feel guilty when I don't exercise	2.05	1.33	-0.54	-1.11
Inj3 – I feel like a failure when I don't exercise	1.77	1.39	0.19	-1.21
BREQ - Identified Regulation (Ide)				
Ide1 – I get restless if don't exercise regularly	2.78	1.20	-1.65	3.09
Ide2 – I think it's important to exercise regularly	3.22	0.94	-1.21	1.03
Ide3 – It's important to me to exercise regularly	3.18	0.99	-1.30	1.59
Ide4 – I value the benefits of exercise	3.34	0.91	-0.82	-0.22
BREQ - Intrinsic Regulation (Int)				
Int1 – I find exercise is a pleasurable activity	3.16	0.96	-1.37	1.86
Int2 – I get pleasure/satisfaction from exercising	3.24	0.93	-1.39	1.91
Int3 – I exercise because it is fun	3.15	1.02	-1.33	1.44
Int4 – I enjoy my exercise sessions	3.09	0.98	-1.09	0.87
Attitudes Towards Exercise (*ATE*)				
ATES1	7.95	1.66	-2.33	5.49
ATES2	7.44	2.09	-2.08	3.52
ATES3	7.64	2.27	-1.95	2.71
Negative Affect Schedule (*NAS*)				
NAS1	1.49	0.86	2.13	4.65
NAS2	1.59	0.89	1.64	2.56
NAS3	1.90	1.09	1.07	0.30
NAS4	1.47	0.92	2.18	4.14
NAS5	1.80	1.17	1.41	0.89
Exercise Behaviour (*ExB*)				
METS	47.18	50.01	4.40	27.74

Note. *BREQ* = Behavioural Regulation in Exercise Questionnaire Scale (Mullan & Markland, 1997). *Skew.* = Univariate Skewness. *Kurt.* = Univariate Kurtosis.

Table 3-2.

Distributional Characteristics of PNSE Items used in CFA and SEM Analyses

PNSE Variables Item abbreviations	*M*	*SD*	*Skew.*	*Kurt.*
PNSE – Perceived Competence				
PNSE2 – able complete challenging exercises	5.05	0.89	-0.93	1.37
PNSE5 – confident I can do challenging exercises	4.59	1.13	-0.64	0.31
PNSE4 – confident in exercise ability	4.85	1.08	-0.98	0.94
PNSE1 – capable of completing exercises	4.91	1.09	-1.12	1.62
PNSE3 – capable of doing challenging exercises	4.71	1.16	-0.90	0.48
PNSE6 – feel good about the way I exercise	4.85	1.10	-0.88	0.78
PNSE – Perceived Autonomy				
PNSE11 – free to exercise in own way	4.97	1.20	-1.09	0.68
PNSE10 – free to make own exercise decisions	4.94	1.15	-0.95	0.64
PNSE9 – feel like I am in charge of exercise program	4.90	1.13	-0.91	0.45
PNSE12 – I have a say in choosing exercises I do	4.96	1.15	-1.26	1.48
PNSE8 – feel free to choose exercise I participate in	4.99	1.11	-1.02	0.81
PNSE7 – I decide what exercises I do	5.01	1.15	-1.18	1.20
PNSE – Perceived Relatedness				
PNSE17 – feel attached to exercise companions	4.42	1.28	-0.86	0.68
PNSE14 – share common bond with important others	4.39	1.27	-0.64	-0.04
PNSE16 – feel sense of camaraderie	4.34	1.37	-0.58	-0.25
PNSE15 – close to exercise companions	4.41	1.21	-0.61	0.24
PNSE18 – feel connected with those I interact with	4.49	1.24	-0.63	-0.06
PNSE3 – get along well with other exercisers	4.54	1.26	-0.75	0.43

Note. *PNSE* = Psychological Need Satisfaction in Exercise Scale. *Skew.* = Univariate Skewness. *Kurt.* = Univariate Kurtosis.

Table 3-3.

Descriptive Statistics, Reliability Estimates, and Bivariate Correlations Between Psychological Need Satisfaction (PNSE), Exercise Regulations (BREQ), and Motivational Consequences

Variables	*M*	*SD*	*Skew.*	*Kurt.*	1	2	3	4	5	6	7	8	9	10
1. PNSE-Perceived Competence	4.83	0.87	-0.74	1.14	.91									
2. PNSE-Perceived Autonomy	4.98	0.96	-0.74	0.34	.80	.94								
3. PNSE-Perceived Relatedness	4.43	0.99	-0.49	0.69	.32	.53	.92							
4. BREQ-External Regulation	1.03	0.97	0.79	-0.09	-.16	.02	-.25	.85						
5. BREQ-Introjected Regulation	1.82	1.14	-0.01	-0.91	.17	.26	.12	.50	.83					
6. BREQ-Identified Regulation	3.12	0.86	-1.18	1.66	.65	.47	.66	-.08	.38	.86				
7. BREQ-Intrinsic Regulation	3.17	0.84	-1.39	2.27	.64	.48	.64	-.09	.30	.82	.92			
8. ATE	7.82	1.69	-1.85	3.32	.45	.32	.55	-.13	.20	.49	.42	.89		
9. NAS	1.64	0.79	1.73	3.42	-.28	-.14	-.34	.33	.12	-.27	-.24	-.20	.85	
10. LTEQ-METS	5.99	2.67	-0.13	0.43	.27	.23	.30	-.07	.21	.36	.28	.23	-.16	-

Note. *PNSE* = Psychological Need Satisfaction in Exercise; *BREQ* = Behavioural Regulation in Exercise Questionnaire. *LTEQ-METS* = Transformed Leisure Time Exercise Questionnaire Score (Godin & Shepherd, 1985). *ATE* = Attitudes Towards Exercise. *NAS* = Negative Affect Schedule. *Skew.* = Univariate Skewness. *Kurt.* = Univariate Kurtosis. Internal consistency reliability estimates (Cronbach's Coefficient α; Cronbach 1951) are placed along the principal diagonal for each multi-item measure.

All *r*'s > |.15| significant at $p < .05$ (two-tailed) and all . All *r*'s > |.20| significant at $p < .01$ (two-tailed).

Table 3-4.

Fit Indices for Measurement and Structural Models Examining PNSE, BREQ, and Motivational Consequences

Criterion Variable	χ^2	*df*	*Q*	*p*	*CFI*	*ΔCFI*	*IFI*	*PNFI*	*RMSEA (90% CI)*
Psychological Need Satisfaction - Exercise									
Oblique 3-Factor Measurement Model	340.29	132	2.58	< .01	.93		.93		.09 (.083 - .108)
Behavioural Regulation in Exercise Questionnaire									
Oblique 4-Factor Measurement Model	187.02	84	2.23	< .01	.94		.94		.08 (.068 - .100)
Attitudes Towards Exercise									
Measurement Model	334.35	174	1.92	< .01	.94		.94		.07 (.061 - .084)
Structural Model 1	427.37	180	2.37	< .01	.90		.90	.72	.08 (.078 - .099)
Structural Model 2	413.64	179	2.31	< .01	.91	.003	.91	.72	.09 (.076 - .097)
Negative Affect									
Measurement Model	346.34	215	1.61	< .01	.95		.95		.06 (.047 - .070)
Structural Model 1	503.44	222	2.27	< .01	.90		.90	.73	.09 (.075 - .095)
Structural Model 2	497.29	221	2.25	< .01	.90	.000	.90	.73	.08 (.075 - .094)
Exercise Behaviour									
Measurement Model	229.38	138	1.66	< .01	.96		.96		.06 (.047 - .076)
Structural Model 1	320.83	144	2.23	< .01	.92		.92	.73	.08 (.072 - .097)
Structural Model 2	320.01	143	2.24	< .01	.92	.000	.92	.72	.09 (.072 - .097)

Note. $Q = \chi^2/df$; *CFI* = Comparative Fit Index; *IFI* = Incremental Fit Index; *RMSEA* = Root Mean Square Error of Approximation; *CI* = Confidence Interval; = Parsimony Normed Fit Index

Structural Model 1 = Model positing full mediation of exercise regulations on the relationship between global need satisfaction and motivational consequences.

Structural Model 2 = Model positing direct and mediated effects between global need satisfaction, exercise regulations, and motivational consequences.

Table 3-5.

Distributional Characteristics of PNSE items used in CFA and SEM Analyses

PNSE Variables Item abbreviations	*M*	*SD*	*Skew.*	*Kurt.*	*FL*	*EV*
PNSE – Perceived Competence						
PNSE2 – able complete challenging exercises	5.05	0.89	-0.95	1.44	.80	.18
PNSE5 – confident I can do challenging	4.59	1.13	-0.65	0.37	.82	.27
PNSE4 – confident in exercise ability	4.85	1.08	-0.99	1.01	.81	.20
PNSE1 – capable of completing exercises	4.91	1.09	-1.22	1.95	.86	.13
PNSE3 – capable of doing challenging exercises	4.71	1.16	-0.90	0.46	.85	.20
PNSE6 – feel good about the way I exercise	4.85	1.10	-0.89	0.79	.67	.31
PNSE – Perceived Autonomy						
PNSE11 – free to exercise in own way	4.49	1.24	-0.63	-0.23	.77	.18
PNSE10 – free to make own exercise decisions	4.54	1.26	-0.79	0.51	.82	.15
PNSE9 – feel like I am in charge of exercise	4.97	1.20	-1.10	0.75	.86	.12
PNSE12 – I have a say in choosing exercises I do	4.94	1.15	-1.04	0.98	.77	.18
PNSE8 – feel free to choose exercise I participate	4.90	1.14	-0.90	0.48	.84	.14
PNSE7 – I decide what exercises I do	4.96	1.15	-1.13	1.59	.82	.16
PNSE – Perceived Relatedness						
PNSE17 – feel attached to exercise companions	4.42	1.26	-0.88	0.75	.75	.79
PNSE14 – share common bond with important	4.39	1.27	-0.63	-0.03	.78	.62
PNSE16 – feel sense of camaraderie	4.34	1.37	-0.57	-0.27	.76	.42
PNSE15 – close to exercise companions	4.41	1.21	-0.62	0.27	.86	.50
PNSE18 – feel connected with those I interact	4.49	1.24	-0.63	-0.02	.85	.24
PNSE3 – get along well with other exercisers	4.54	1.26	-0.79	0.51	.92	.52

Note. Skew. = Univariate Skewness Values. Kurt. = Univariate Kurtosis values. *FL* = Factor Loading; *EV* = Error Variance.

Table 3-6.

Distributional Characteristics of BREQ items used in CFA and SEM Analyses

BREQ Variables Item Abbreviations	*M*	*SD*	*Skew*	*Kurt*	*FL*	*EV*
BREQ - External Regulation (Ext)						
Ext1 – I feel pressured to exercise by friends/family	1.34	1.27	0.49	-0.89	.71	.53
Ext2 – exercise because others say I should	1.03	1.17	0.92	-0.06	.88	.16
Ext3 – exercise because others would not be pleased	0.85	1.16	1.22	0.52	.68	.20
Ext4 – I exercise because others say I should	0.91	1.19	1.61	0.26	.88	.14
BREQ - Introjected Regulation (Inj)						
Inj1 – I feel ashamed when I miss an exercise	1.63	1.28	0.29	-0.99	.80	.45
Inj2 – I feel guilty when I don't exercise	2.04	1.33	-0.06	-1.11	.80	.50
Inj3 – I feel like a failure when I don't exercise	1.77	1.39	0.19	-1.21	.70	.78
BREQ - Identified Regulation (Ide)						
Ide1 – I get restless if don't exercise regularly	2.78	1.20	-0.83	-0.19	.68	.68
Ide2 – I think it's important to exercise regularly	3.22	0.94	-1.31	1.67	.91	.11
Ide3 – It's important to me to exercise regularly	3.19	0.96	-1.38	1.95	.79	.07
Ide4 – I value the benefits of exercise	3.34	0.91	-1.66	3.22	.50	.08
BREQ - Intrinsic Regulation (Int)						
Int1 – I find exercise is a pleasurable activity	3.16	0.96	-1.38	1.95	.86	.12
Int2 – I get pleasure/satisfaction from exercising	3.24	0.93	-1.23	1.09	.69	.13
Int3 – I exercise because it is fun	3.15	1.02	-1.35	1.51	.81	.19
Int4 – I enjoy my exercise sessions	3.09	0.98	-1.09	0.93	.78	.13

Note. Skew. = Univariate Skewness Values. Kurt. = Univariate Kurtosis values. *FL* = Factor Loading; *EV* = Error Variance.

Table 3-7.

Descriptive Statistics, Paired Samples T-tests, and Intraclass Correlation Coefficients for PNSE and BREQ Variables Across 10-Weeks

	Time 1			*Time 2*						
Variables	*M*	*SD*	α	*M*	*SD*	α	*t*	*95% CI*	*ES*	*R*
PNSE-Perceived Competence	5.17	0.73	.91	5.39	0.64	.93	3.80**	.11 - .34	.32	.56**
PNSE-Perceived Autonomy	5.38	0.70	.91	5.52	0.59	.93	2.43**	.03 - .27	.23	.52**
PNSE-Perceived Relatedness	4.46	1.04	.92	4.62	1.05	.92	2.02*	.00 - .27	.19	.69**
BREQ-External Regulation	0.66	0.81	.86	0.69	0.80	.86	0.37	-.11 - .16	.03	.62**
BREQ-Introjected Regulation	1.99	1.07	.80	2.01	1.09	.86	0.27	-.13 - .17	.02	.72**
BREQ-Identified Regulation	3.49	0.56	.72	3.60	0.44	.65	2.61**	.11 - .34	.24	.53**
BREQ-Intrinsic Regulation	3.36	0.69	.88	3.46	0.64	.85	2.07*	.01 - .19	.20	.74**

Note. *PNSE* = Psychological Need Satisfaction in Exercise Scale. *BREQ* = Behavioural Regulation in Exercise Questionnaire (Mullan et al., 1997). α = Cronbach's (1951) Internal Consistency Reliability Coefficient. *t* = paired samples t-tests over 10-week period. *ES* = Effect Size (Cohen's d) calculated using the procedures suggested for paired observations (Dunlap, Cortina, Vaslow, & Burke, 1996; Johnson & Eagly, 2000) and the following equation: $(M_1 - M_2)/SD_{difference}$. 95% *CI* = Ninety-five percent Confidence Interval around the difference score. *R* = Intraclass correlation coefficient between time 1 and time 2 assessments.

$** = p < .01$. $* = p < .05$.

Table 3-8.

Bivariate Correlations Between Psychological Need Satisfaction (PNSE) and Exercise Regulations (BREQ) at Study Outset

Variables	1	2	3	4	5	6	7
1. PNSE-Perceived Competence	-						
2. PNSE-Perceived Autonomy	.59	-					
3. PNSE-Perceived Relatedness	.32	.17	-				
4. BREQ-External Regulation	-.20	-.16	.05	-			
5. BREQ-Introjected Regulation	-.05	-.06	-.00	-.35	-		
6. BREQ-Identified Regulation	.48	.37	.23	-.19	.19	-	
7. BREQ-Intrinsic Regulation	.51	.40	.27	-.23	-.01	.58	-

Note. *PNSE* = Psychological Need Satisfaction in Exercise; *BREQ* = Behavioural Regulation in Exercise Questionnaire. All *r*'s > .15 significant at $p < .05$ (two-tailed). All *r*'s > .20 significant at $p < .01$ (two-tailed significance).

Table 3-9.

Bivariate Correlations Between PNSE and BREQ Change Scores Across 10-Weeks

Variables	*1*	2	*3*	*4*	*5*	*6*	*7*
1. PNSE-Perceived Competence	-						
2. PNSE-Perceived Autonomy	.50	-					
3. PNSE-Perceived Relatedness	.33	.32	-				
4. BREQ-External Regulation	-.08	-.24	.05	-			
5. BREQ-Introjected Regulation	.09	.12	.18	.29	-		
6. BREQ-Identified Regulation	.21	.34	.03	-.09	.22	-	
7. BREQ-Intrinsic Regulation	.34	.44	.22	-.08	.11	.47	-

Note. *PNSE* = Perceived Psychological Need Satisfaction in Exercise Scale. *BREQ* = Behavioural Regulation in Exercise Questionnaire (Mullan et al., 1997).
All *r*'s > .20 significant at *p* < .05 (two-tailed).

Footnote

1. Although not shown in Figures 3-3, 3-4, and 3-5 for the purposes of clarity, moderate-to-strong factor loadings were observed across the SEM analyses predicting (a) Attitudes Towards Exercise (psychological need satisfaction λ's ranged from .63 to .84; *BREQ* λ's ranged from .69 to .90; Attitude Towards Exercise λ's ranged from .75 to .83); (b) Exercise Behaviour (psychological need satisfaction λ's ranged from .63 to .84; *BREQ* λ's ranged from .66 to .90); and (c) Negative Affect (psychological need satisfaction λ's ranged from .63 to .84; *BREQ* λ's ranged from .67 to .88; Negative Affect λ's ranged from .74 to .90).

Figure Captions

Figure 3-1. Confirmatory Factor Analysis of *PNSE.*

Note to Figure 3-1: Large circles represent latent *PNSE* factors. Small rectangles represent manifest *PNSE* items. Standardized factor loadings (λ's) are placed along the pathway from latent factors to each manifest item (all p's $< .001$). Small circles represent residual error variances. Interfactor correlation estimates (ϕ) are presented for each pair of *PNSE* latent variables.

Figure 3-2. Confirmatory Factor Analysis of *BREQ.*

Note to Figure 3-2: Large circles represent latent *BREQ* factors. Small rectangles represent manifest BREQ items. Standardized factor loadings (λ's) are placed along the pathway from latent BREQ factors to each manifest item (all p's $< .001$). Small circles represent residual error variances. Interfactor correlation estimates (ϕ) are presented between *BREQ* factors.

Figure 3-3. Structural Equation Model Predicting Attitudes Towards Exercise.

Note to Figure 3-3: Path coefficients represent standardized estimates using maximum likelihood estimation procedures. Solid lines are statistically significant ($p < .05$). Dashed lines are nonsignificant ($p > .05$).

Figure 3-4. Structural Equation Model Predicting Exercise Behaviour.

Note to Figure 3-4: Path coefficients represent standardized estimates using maximum likelihood estimation procedures. Solid lines are statistically significant ($p < .05$). Dashed lines are nonsignificant ($p > .05$).

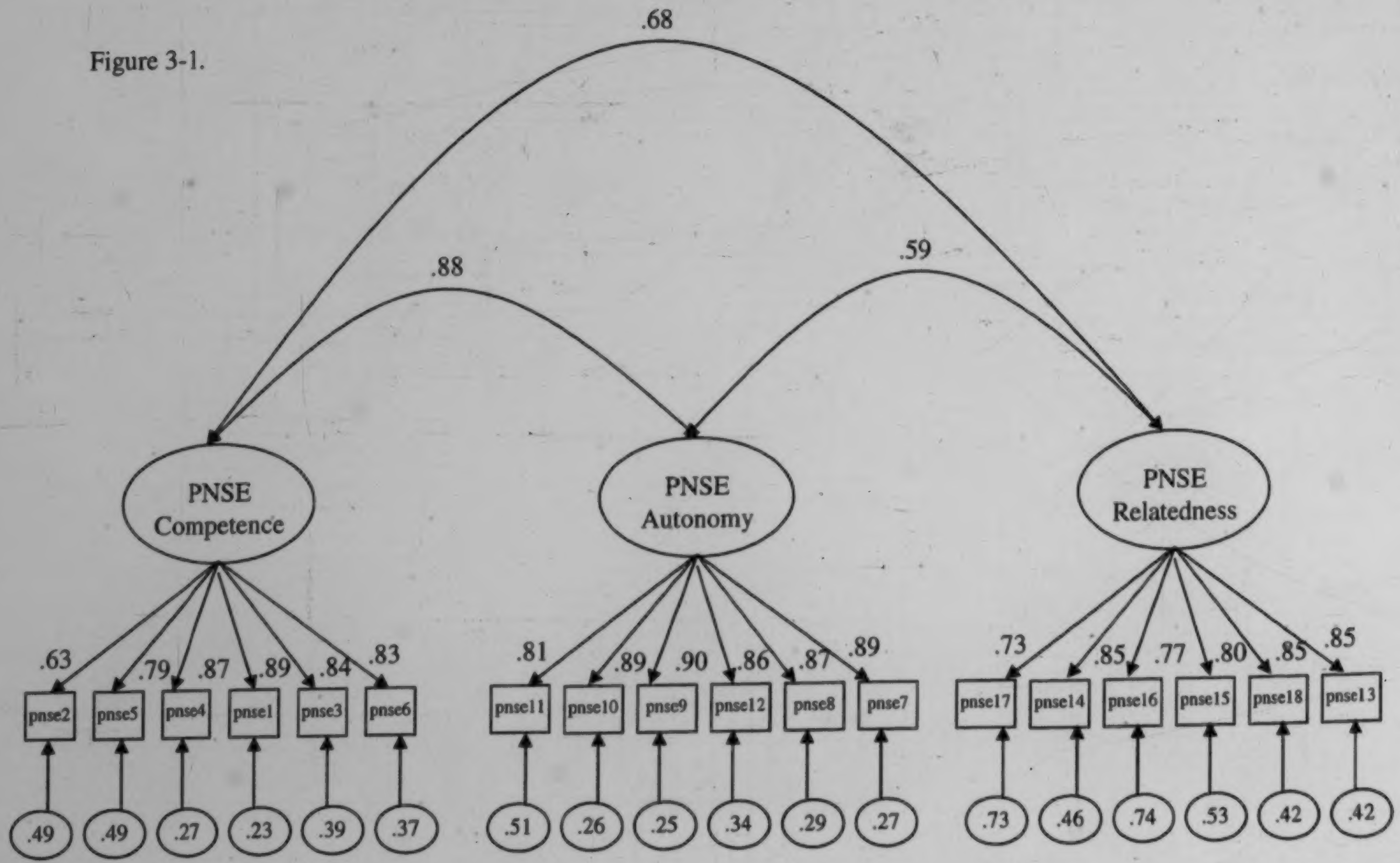
Figure 3-5. Structural Equation Model Predicting Negative Affect.

Note to Figure 3-5: Path coefficients represent standardized estimates using maximum likelihood estimation procedures. Solid lines are statistically significant ($p < .05$). Dashed lines are nonsignificant ($p > .05$).

Figure 3-6. Structural Equation Model Predicting Exercise Regulations from Perceptions of Psychological Need Satisfaction.

Note to Figure 3-6: Path coefficients represent standardized estimates using maximum likelihood estimation procedures. Solid lines are statistically significant ($p < .05$). Dashed lines are nonsignificant ($p > .05$).

Figure 3-1.


.68
.88
.59
PNSE Competence
PNSE Autonomy
PNSE Relatedness
.63
.79
.87
.89
.84
.83
.81
.89
.90
.86
.87
.89
.73
.85
.77
.80
.85
.85
pnse2
pnse5
pnse4
pnse1
pnse3
pnse6
pnse11
pnse10
pnse9
pnse12
pnse8
pnse7
pnse17
pnse14
pnse16
pnse15
pnse18
pnse13
.49
.49
.27
.23
.39
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.25
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.29
.27
.73
.46
.74
.53
.42
.42

Figure 3-2.

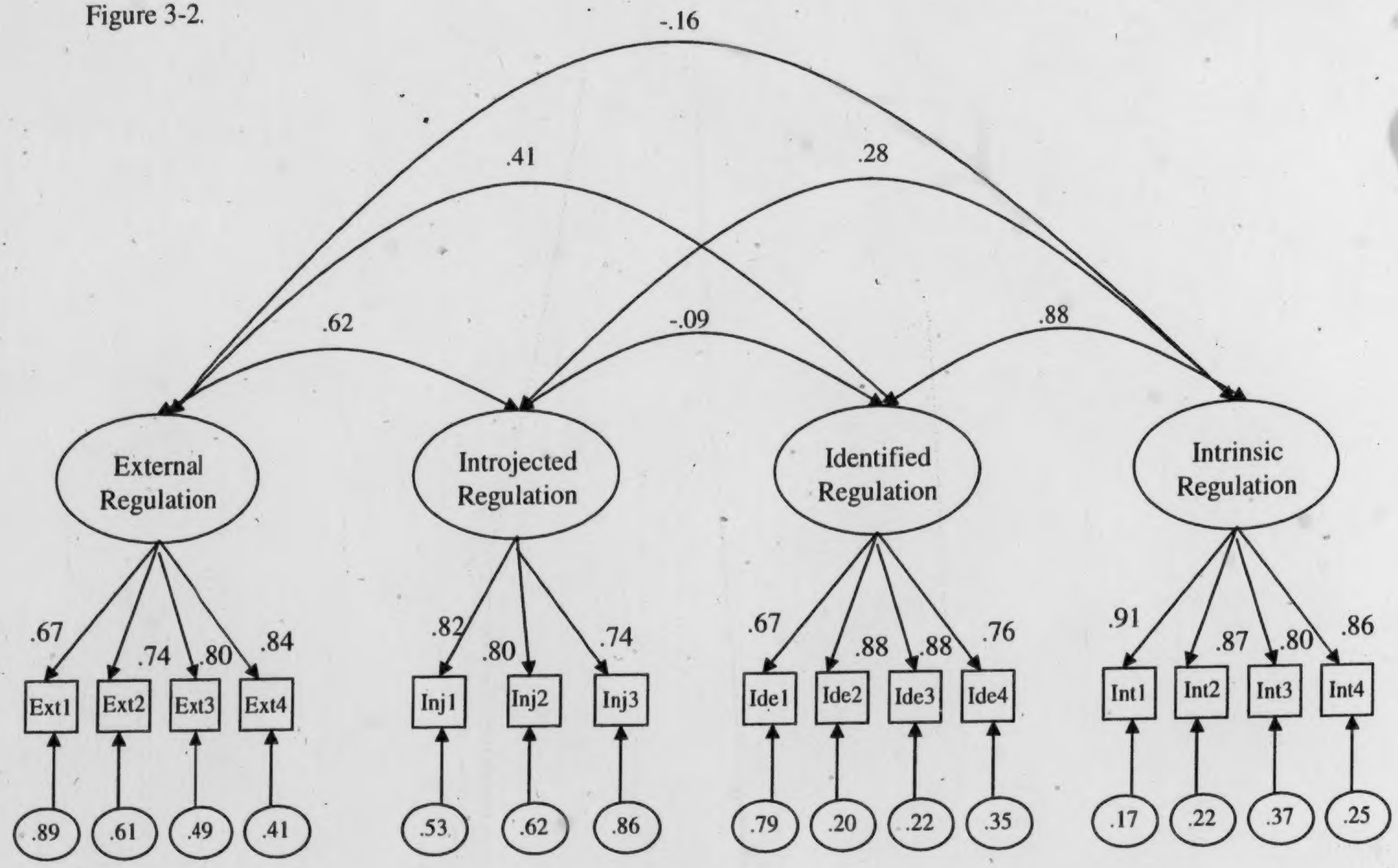

-.16
.41
.28
.62
-.09
.88
External Regulation
Introjected Regulation
Identified Regulation
Intrinsic Regulation
.67
.74
.80
.84
.82
.80
.74
.67
.88
.88
.76
.91
.87
.80
.86
Ext1
Ext2
Ext3
Ext4
Inj1
Inj2
Inj3
Ide1
Ide2
Ide3
Ide4
Int1
Int2
Int3
Int4
.89
.61
.49
.41
.53
.62
.86
.79
.20
.22
.35
.17
.22
.37
.25

Figure 3-3.

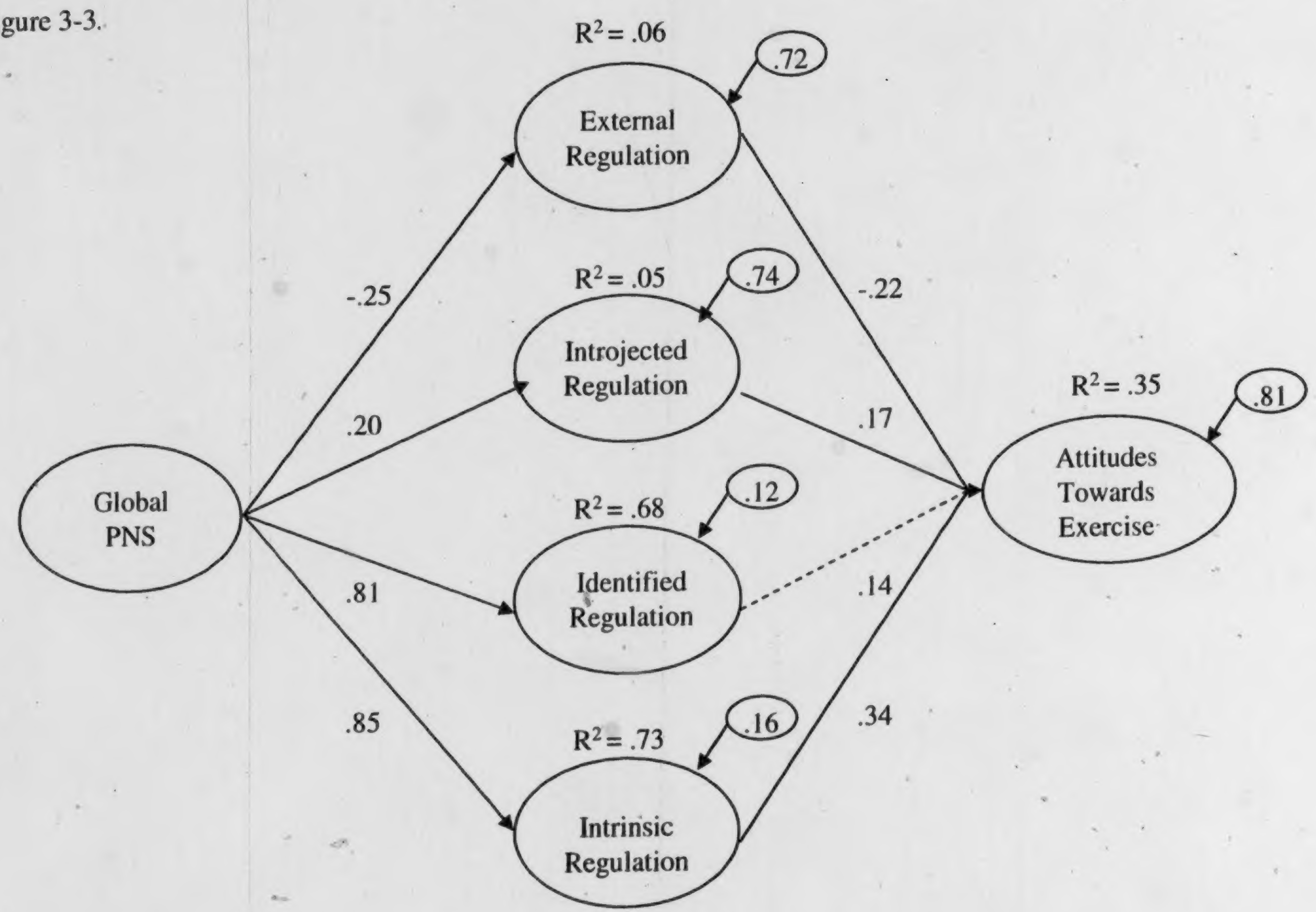

Global PNS
$R^2 = .06$
.72
External Regulation
$R^2 = .05$
.74
Introjected Regulation
$R^2 = .68$
.12
Identified Regulation
$R^2 = .73$
.16
Intrinsic Regulation
-.25
.20
.81
.85
-.22
.17
.14
.34
$R^2 = .35$
.81
Attitudes Towards Exercise

Figure 3-4.

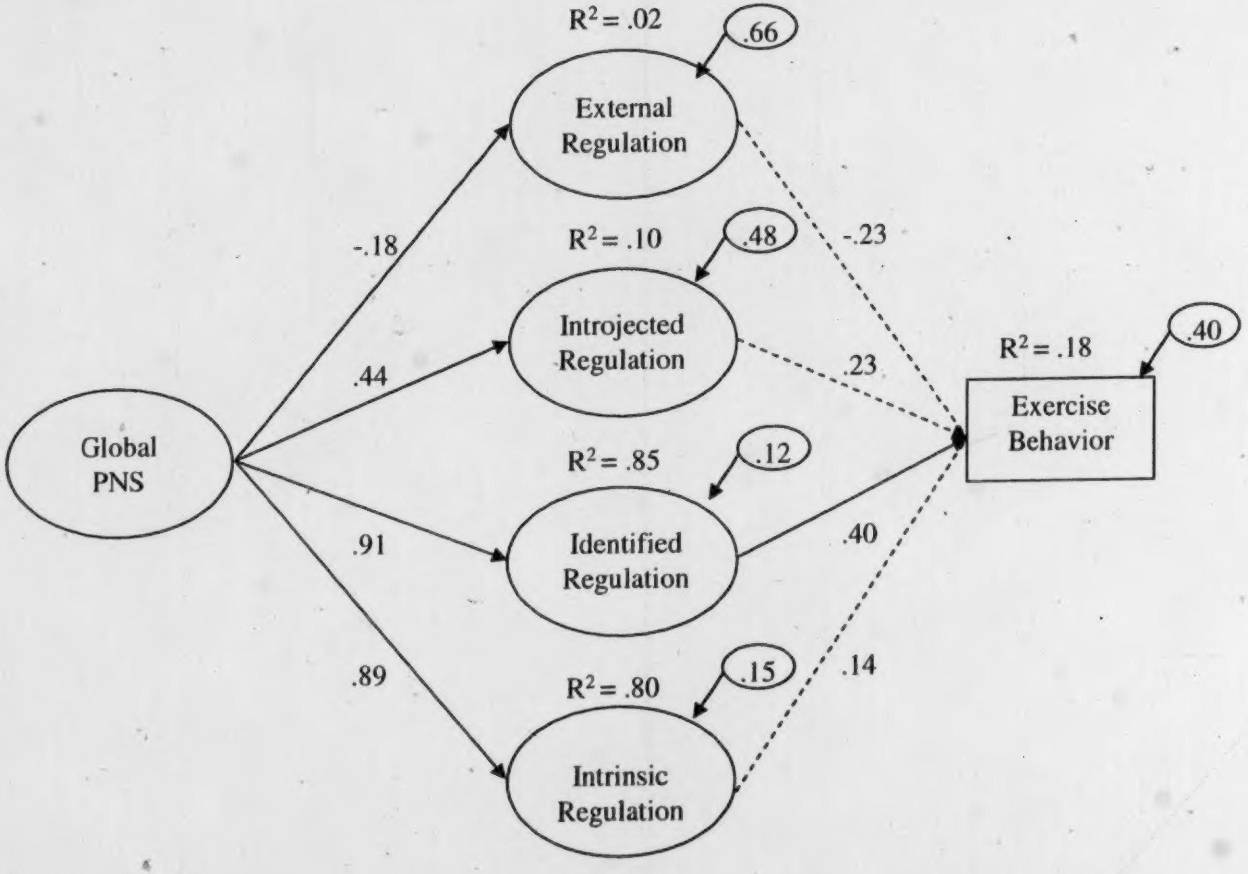

Global PNS
R² = .02
.66
External Regulation
R² = .10
.48
Introjected Regulation
R² = .85
.12
Identified Regulation
R² = .80
.15
Intrinsic Regulation
-.18
.44
.91
.89
-.23
.23
.40
.14
R² = .18
.40
Exercise Behavior

Figure 3-5.

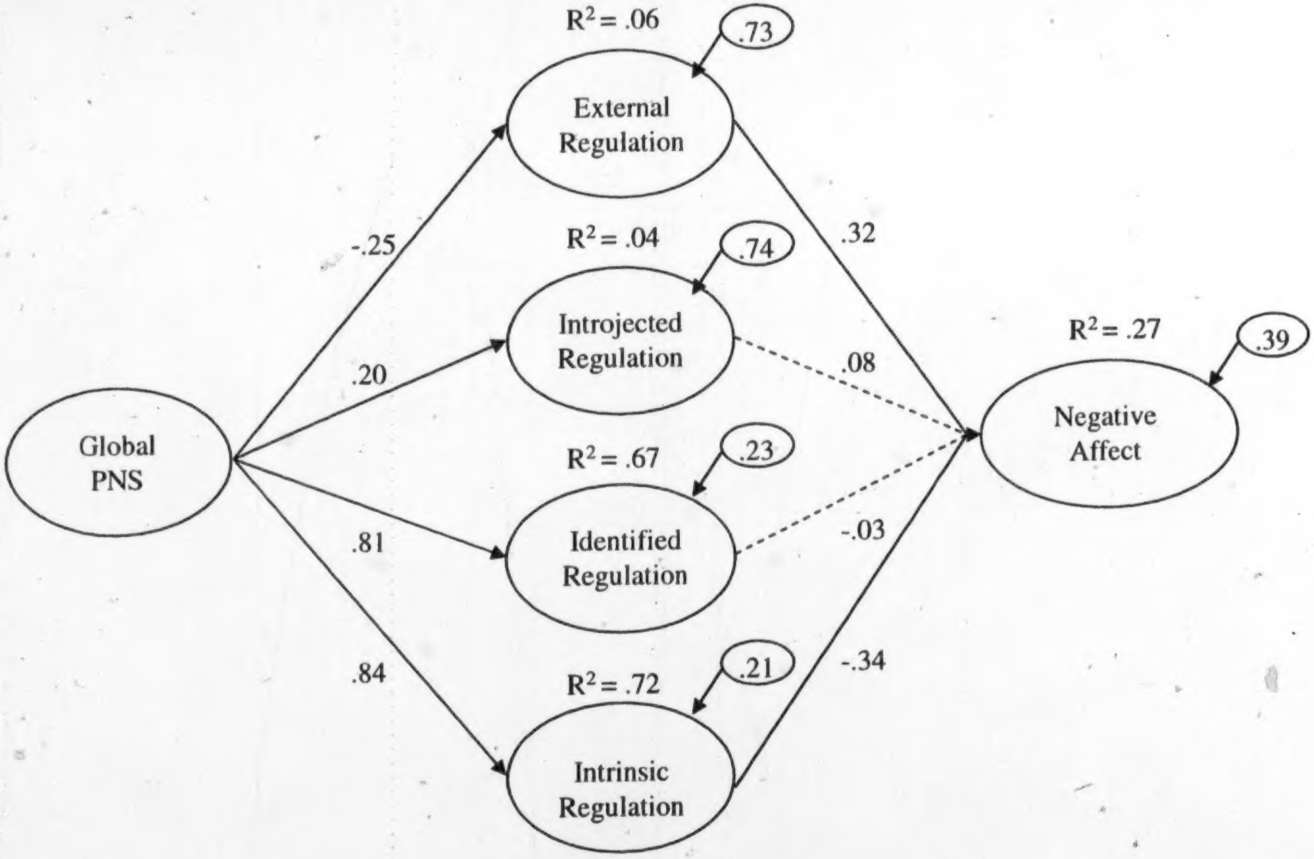
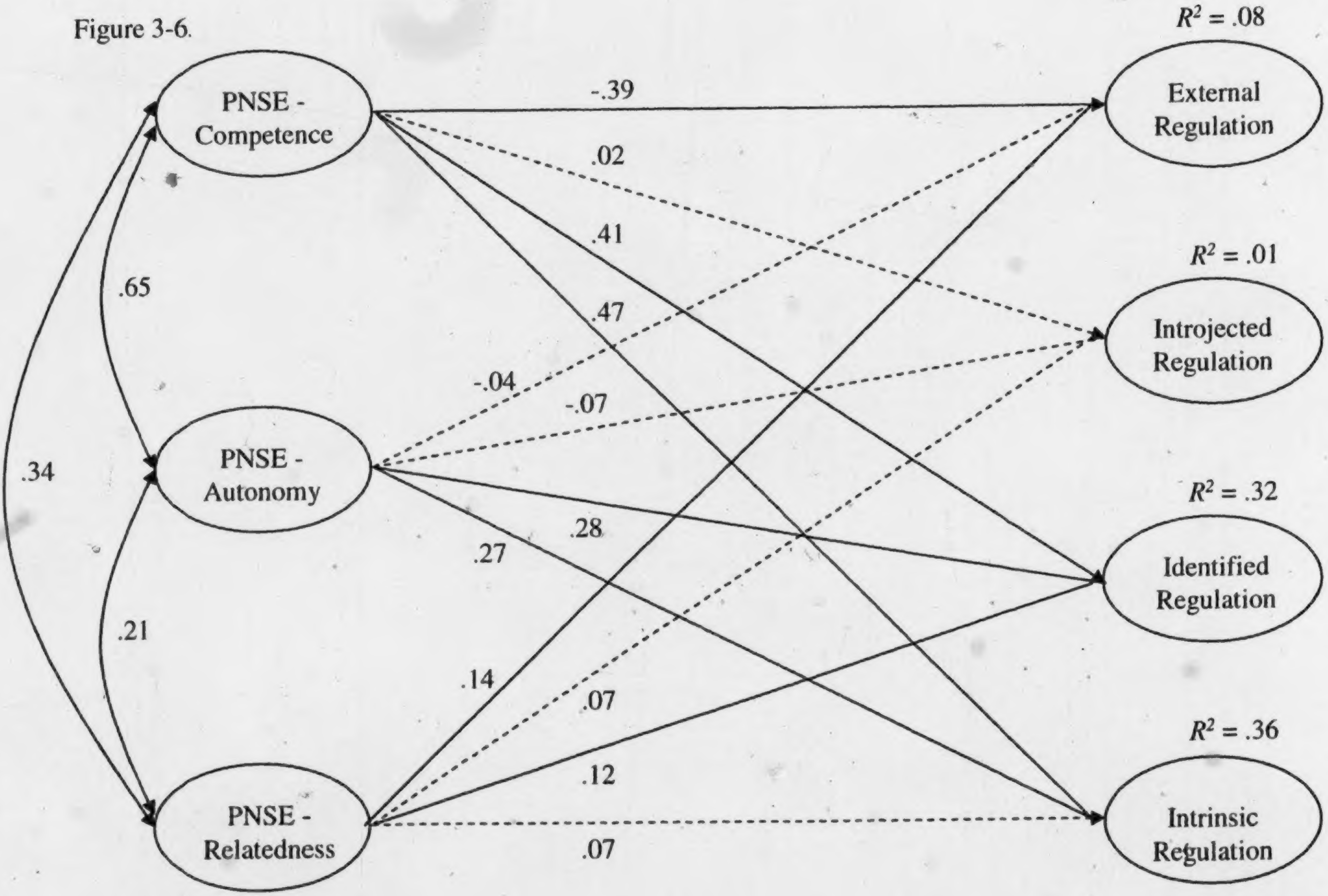

$R^2 = .06$
.73
External Regulation
$R^2 = .04$
.74
Introjected Regulation
$R^2 = .67$
.23
Identified Regulation
$R^2 = .72$
.21
Intrinsic Regulation
Global PNS
-.25
.20
.81
.84
.32
.08
-.03
-.34
$R^2 = .27$
.39
Negative Affect

Figure 3-6.


$R^2 = .08$
$R^2 = .01$
$R^2 = .32$
$R^2 = .36$
PNSE - Competence
PNSE - Autonomy
PNSE - Relatedness
External Regulation
Introjected Regulation
Identified Regulation
Intrinsic Regulation
-.39
.02
.41
.47
-.04
-.07
.28
.27
.14
.07
.12
.07
.65
.21
.34

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Summary

The first objective of this research was to develop an instrument for measuring perceived competence, autonomy, and relatedness in exercise contexts. The results of studies 2 and 3 suggest that the *PNSE* items crafted on the basis of both experiential and theoretical input in study 1 have good psychometric properties compared both with conventional standards and existing instruments. The second objective of the foregoing research was to test SDT's proposition that need satisfaction facilitates the internalization process exemplified by the endorsement of more self-determined exercise regulations. The results of study 3 supported this theoretical contention in exercise contexts given that perceived competence and autonomy, and to a lesser extent relatedness, predicted more self-determined exercise regulations, and changes in need satisfaction correlated positively with changes in identified and intrinsic exercise regulations. Identified regulation was a stronger predictor of exercise behavior in study 3 suggesting that all extrinsic motives do not promote undesirable consequences. Collectively, the results of study 3 substantiate SDT's proposition that need satisfaction is a central mechanism in motivational processes, and self-determined extrinsic motives promote more desirable consequences than their controlling counterparts.

The results of the three studies comprising this dissertation have implications for future applications of SDT to the study of psychological processes involved in exercise motivation and behaviour. Study 1 revealed that although the majority of participants reported need satisfying experiences that are in line with theoretical arguments (Deci & Ryan, 1985; 2002; Ryan, 1995), a portion of the participants indicated that they had no need to feel related to others in exercise contexts. While this observation poses no serious threat to SDT's argument regarding the universality of relatedness, it does highlight the importance of considering individual needs during the development of interventions designed to promote exercise behavior. For example, it is conceivable on the basis of study 1 that some people do not want to feel related to others while exercising, and consequently, the effects of structuring environmental conditions to enhance feelings of meaningful connection with others might be counterintuitive to the intervention's behavioural change goals. Although tailoring exercise interventions to individuals is hardly a novel practice, the experiential qualities that promote need satisfaction particularly with regards to relatedness in exercise are unique to this study. Future research may wish to consider the extent to which social contexts satisfy psychological needs, in conjunction with an individual's need satisfaction requirements, at the outset of exercise behaviour interventions using SDT's psychological needs as the catalyst for change.

The results of studies 2 and 3 supported the factorial composition, structure, and internal consistency of the scores derived from the *PNSE*. The CFA tests of the *PNSE* in studies 2 and 3 using samples that were heterogeneous in their demographic composition substantiates the pattern of within network relationships comprising the internal structure of the *PNSE* (Loevinger, 1957; Marsh, 1997). Consistent with calls for repeated assessment of scale dimensionality across populations of interest (Messick, 1989; 1995), the overall findings of these studies bode well for the future of the *PNSE* as a measure of perceived psychological need satisfaction within exercise contexts based on SDT's framework (Deci & Ryan, 1985; 2002; Ryan, 1995). One additional point of interest emerging from study 2 was the demonstration of invariance of *PNSE* scores across male and female subsamples. This measurement property is particularly desirable because SDT contends that experiences promoting need satisfaction can vary across sex; however, the effects of need satisfaction in terms of motivational development and psychological health are theorized to be equivalent (Deci & Ryan, 2002). Given that men are more physically active than women (United States Department of Health & Human Services, 1996), future research can use the *PNSE* in studies comparing motivational processes across sexes with confidence that the items are being interpreted uniformly.

The results of study 2 suggested that using the *IMI-PC* and *LOCE* as indices of perceived autonomy in exercise is a questionable practice. From a psychometric standpoint, the pattern of correlations with the *PNSE-Perceived Autonomy* and *PNSE-Perceived Competence* subscales provided minimal support for the convergence of scores across instruments, and the descriptive statistics implied the presence of methods effects in both scales associated with the item wording. Notwithstanding this observation, while both the *IMI-PC* and *LOCE* were used in study 2 as proxy measures of need satisfaction, Reeve (2002) proposed that these experiences form merely a portion of the feelings that comprise perceived autonomy from SDT's perspective. While the present results do not pose a serious threat to the construct validity of either the *IMI-PC* or the *LOCE*, they do highlight the importance of clearly identifying and measuring the focal construct of interest to prevent interpretational difficulties stemming from construct labelling (Marsh, 1994). Considering this conceptual quandary, it is recommended that future studies carefully select the instrument that captures the nature of the focal construct of interest, and subject both the *IMI-PC* and *LOCE* to more stringent psychometric scrutiny prior to adopting these scales as instruments of choice in exercise motivation research.

In addition to corroborating the psychometric credentials of the *PNSE*, the results of study 3 supported two of SDT's central propositions. The first proposition contends that perceptions of need satisfaction represent important mechanisms in motivational development. This proposition was supported in two ways in study 3. First, the results of the SEM analyses indicated that overall need satisfaction underpins greater endorsement of both identified and intrinsic exercise regulations. Second, an inspection of the relationships amongst the transformed scores conducted in phase 2 of study 3 indicated that changes in need satisfaction correlated with changes in both controlling and self-determined exercise regulations in a manner that is consistent with SDT. Although these studies relied heavily on correlational techniques, the converging lines of evidence from both the SEM and the change score analyses suggested that perceived need satisfaction is at least one potential mechanism through which self-determined exercise regulations develop.

A closer inspection of the SEM analyses in phase 2 of study 3 provides additional support for SDT's argument that satisfaction of autonomy and relatedness needs are central features of motivational processes (Deci & Ryan, 1985; 2002; Ryan, 1995). On the basis of the data presented in phase 2 of study 3, it is clear that both autonomy and relatedness play a role in identified regulation irrespective of how competent one feels towards exercise. The data also indicate that feeling meaningfully connected to others in exercise contexts is not associated with intrinsic motivation when considered concurrently with perceptions of competence and autonomy. Although not originally hypothesized, these data support theoretical arguments contending that perceived relatedness "provides the groundwork facilitating internalization" (Ryan & Deci, 2000, p. 64) and may not be a necessary condition for pure intrinsic regulation of exercise behaviour. This observation supports recent arguments forwarded by Koesnter and Losier (2002) who suggested relatedness and autonomy may be more important to the internalization of extrinsic motives, whereas perceived autonomy and competence represent the dominant need satisfaction mechanisms fostering intrinsic regulation.

Given the lack of systematic research examining perceived relatedness in exercise contexts (Frederick-Recascino, 2002; Vallerand, 2001), it seems prudent to offer to an alternative explanations for the observed relationships between perceived relatedness and intrinsic exercise regulation. First, it is possible that relatedness plays a more important role in intrinsic regulation of exercise behavior in older exercisers as suggested in previous research (Kowal & Fortier, 2000). Second, it is possible that the structured exercise contexts examined in these studies do not permit participants to engage in clearly defined social roles and instead encourage feelings of being "lost in the crowd" that are unlikely to facilitate a sense of meaningful connection to others (Bettencourt & Sheldon, 2001; Sheldon & Bettencourt, 2002). Although these conclusions are speculative at this juncture, they highlight the importance of examining theoretical boundaries in an attempt to gain a greater understanding of the nature and function of psychological constructs such as perceived relatedness (Palys, 1992).

The second proposition central to SDT that was supported by the data in phase 1 of study 3 was the importance of conceptualizing extrinsic motivation from a multidimensional perspective. The results of the SEM analyses (see Figures 3-3, 3-4, & 3-5) revealed that more self-determined exercise motives, irrespective of their intrinsic or extrinsic quality, exert a positive influence on behavioural and psychological indices in comparison with their controlling counterparts. This finding suggests that the critical practical implication associated with behavioural and psychological health promotion concerns the distinction between self-determined versus controlling regulations rather than their intrinsic or extrinsic orientation. Together with support for the link between perceived autonomy and identified regulation, one practical implication of these results is that the provision of choices and support of volition could encourage behavioural change because the outcomes associated with the behaviour itself become personally valued and meaningful. Although this conclusion remains speculative, this notion has empirical support in educational contexts (Reeve, Jang, Hardre & Omura, 2002) and holds considerable promise for future interventions designed to promote exercise participation through motivational change.

An additional observation that has important practical and theoretical ramifications regarding the measurement and statistical treatment of exercise regulations can be noted from the results of study 3. In the SEM analyses, the contributions of each BREQ subscale were examined separately rather than combining the weighted subscales into a Relative Autonomy Index (RAI) as previous exercise research has done (e.g., Kowal & Fortier, 2000). The approach utilized in the present investigation revealed important differences in the predictive capacity of both self-determined and controlled forms of exercise regulation that would have remained masked had the RAI been employed. Koestner and Losier (2002) have questioned the practice of summing distinct regulations into an RAI given that the transformed variable loses the subtle theoretical distinctions between the quality of motivation underpinning behavioural and psychological consequences of interest. Corroborating both Koestner and Losier's arguments, a growing body of evidence now supports the beneficial effects stemming from identified exercise regulation on behavioural and psychological outcomes (Wilson & Rodgers, 2002; Wilson & Rodgers, in press; Wilson, Rodgers, Fraser, & Murray, in press). On the basis of these findings, as well as theoretical arguments (Deci & Ryan; 2002; Koestner & Losier, 2002), future research should consider measuring and analysing extrinsic motives at a multivariate level in an attempt to bring theoretical clarity and refinement to applications of SDT within exercise contexts.

Despite the insights provided through the studies comprising this dissertation into applications of SDT to exercise motivation, a number of study-specific and general limitations should be acknowledged. Two central limitations were evident in study 1. First, the nature of the open-ended questions posed in phase 1 restricted the participants to providing experiential accounts of exercise-specific events that contributed towards feelings of competence, autonomy, and relatedness at the expense of providing insight into other psychological needs or processes. Research by Sheldon et al. (2001) suggests that a number of psychological needs contribute towards personally satisfying experiences and future research may wish to examine the degree to which the satisfaction of psychological needs external to SDT's framework play a role in the internalization processes central to exercise motivation. In addition to the restrictive nature of phase 1, a second limitation of study 1 concerned the lack of a subsequent expert review of the revised *PNSE* items developed at the end of phase 2. While it seems reasonable to suggest that the data attesting to the relevance and representativeness of the initial *PNSE* items was promising, no additional content validity evidence was sought after the modifications were made to the initial *PNSE* items prior to embarking upon study 2. Although the results of studies 2 and 3 support the changes made to the initial set of *PNSE* items resulting from phase 2 in study 1, future research may wish to examine the degree of content relevance and representation associated with the final set of *PNSE* items using the procedures advocated by Dunn et al. (1999) as a means of augmenting the *PNSE*'s construct validity.

In contrast to study 1, the major limitation of study 2 concerned the nature of instruments selected that restricted their focus to conceptually analogous measures of perceived competence, autonomy, and relatedness in exercise contexts. Although the results of study 2 were promising with regards to the pattern of relationships exhibited by both the competence and relatedness subscales of the *PNSE* and their respective proxy measures (namely the *IMI-C* and the *MPAMR-S* and *EMI-A*), the lack of convergence between the *PNSE-Perceived Autonomy* subscale and conceptually relevant constructs is troubling and warrants scrutiny in future applications of the *PNSE*. Future research using the *PNSE* may wish to incorporate both self-report and behaviourally based measures of conceptually similar and antithetical constructs, such as tension and alienation, to further illuminate the degree of convergent validity associated with the *PNSE* scores.

In conjunction with studies 1 and 2, the results of study 3 are limited in terms of their ability to evaluate the causal nature of the relationship between perceived psychological need satisfaction and exercise regulations. While SDT's (Deci & Ryan, 1985; Ryan, 1995; Ryan &

Deci, 2000) contention that perceived psychological need satisfaction gives rise to various motives appears tenable in exercise contexts on the basis of the SEM analyses, the causal implications underpinning this proposition were not directly tested in this study. Consequently, it is not possible on the basis of the research presented herein to conclude that perceived need satisfaction "causes" exercise motivation. Future research would do well to examine SDT's contentions more carefully using experimental designs that facilitate a clearer examination of causal influences attributable to SDT's constructs. In conjunction with the limitations surrounding causality, the interpretations stemming from the change score analysis should be made with caution given the concern surrounding the use of residual change scores as indices of true change (Rogosa, 1995) and the presence of ceiling effects evident in the descriptive statistics reported in the first assessment of the *PNSE* that limited the magnitude of the change possible during the study.

In conjunction with the study specific limitations observed in the present studies, a number of general limitations warrant consideration for future research using the *PNSE*. First, all of the studies comprising this dissertation used intact group sampling procedures that restrict the generalizability of the results. Consequently, the results of this study should be regarded as tentative prior to future replications using more sophisticated sampling procedures and examining various demographic (e.g., older adults, community-based participants, symptomatic groups) and exercise (e.g., resistance training, yoga) cohorts that attest to the degree of external validity associated with the findings of the studies comprising this dissertation. Second, the data generated in each study comprising this dissertation relied exclusively on self-report instruments that are susceptible to contamination from common methods variance. Although objective indicators of perceived psychological need satisfaction may be difficult to obtain, future research should endeavour to identify more behavioural based markers that should be conceptually related to the *PNSE* in accordance with SDT's nomological net (Cronbach & Meehl, 1955). Finally, the research designs employed in the studies comprising this dissertation make it difficult to establish the elements of change associated with perceptions of need satisfaction in exercise contexts. Future research may wish to measure perceptions of need satisfaction across three or more time points to gain greater insight into the nature and rate of change associated with need satisfaction variables measured by the *PNSE*. Notwithstanding this observation, it is acknowledged that psychometricians have yet to agree on the number of time points required to adequately establish change, although it does seem reasonable to suggest that two observations are unlikely to adequately capture the complexities associated with change over time (Rogosa, 1995).

In summary, the practical importance of the foregoing three studies is tied to the growing interest in understanding exercise motivation from an SDT perspective. The results of these studies illustrate the breadth and diversity of experiences in exercise that contribute to psychological need satisfaction. Perceptions of competence, autonomy, and relatedness represent important mechanisms involved in exercise motivation, and the *PNSE* holds considerable promise as a measure of these theoretical constructs in exercise domains. Critics might argue that the development of the *PNSE* broadens the conceptual lens associated with the psychological processes nurturing different exercise motives, and as such, results in an overall loss in parsimony. Such a criticism should be tempered with caution, however, since the development of the *PNSE* facilitates the examination of hypotheses surrounding need satisfaction that is equally important in terms of extending SDT's limits and testing the nomological net proposed by Deci and Ryan (1985; 2002) in exercise contexts.

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Appendix A

Demographics

These questions will be used to describe the participants in this study. Please provide your…

1. Age:		years	**3. Height**		inches or metres
2. Sex:			**4. Weight**		pounds or Kgs.

Godin Leisure Time Exercise Questionnaire

These questions will be used to describe your exercise participation over the past week. Considering only the past week…

***How many TIMES** did you participate in the following types of regular exercise for **more than 20 minutes last week**?*

		TIMES PER WEEK
• **Mild Exercise**	*These exercises require minimal effort and usually don't cause you to sweat. Examples include **easy walking, yoga, & bowling***	
• **Moderate Exercise**	*These exercises are not exhausting but require some effort and might produce light perspiration. Examples include **badminton, volleyball, & easy bicycling**.*	
• **Strenuous Exercise**	*These exercises are exhausting and typically cause sweating and rapid heart beats. Examples include **vigorous swimming, running, aerobics, & heavy strength training**.*	

Open-ended Probes eliciting Perceptions of Psychological Need Satisfaction

The following questions ask you to describe in your own words some of your exercise experiences.

Relatedness refers to FEELING meaningfully connected with other people involved in an activity

Think about a time when you felt ***RELATED*** *during an exercise session. Describe in your own words what specifically made you feel this way?*

What specific changes would make you feel ***"more"*** *or* ***"less" RELATED*** *during an exercise session?*

Autonomy refers to FEELING that your activities reflect your own choices and values

Think about a time when you felt ***AUTONOMOUS*** *during an exercise session. Describe in your own words what specifically made you feel this way?*

What specific changes would make you feel ***"more"*** *or* ***"less" AUTONOMOUS*** *during an exercise session?*

Competence refers to FEELING that your are able to perform challenging activities effectively

Think about a time when you felt ***COMPETENT*** *during an exercise session. Describe in your own words what specifically made you feel this way?*

What specific changes would make you feel ***"more"*** *or* ***"less" COMPETENT*** *during an exercise session?*

Item Content Review Form (ICRF)

The following is a preliminary item pool designed to measure what events satisfy the psychological needs for competence, autonomy, and relatedness when people exercise. The overall purpose of these items is to provide a measure of participants' psychological need satisfaction with respect to exercise and facilitate an examination of exercise motivation and well-being issues from the perspective of Deci and Ryan's (1985) Self-Determination Theory. The items were developed from participant responses to open-ended questions asking them to describe in their own words what events satisfied each psychological need when they exercise. Every attempt has been made to ensure that the preliminary items are understandable and reflect wording that participants used to describe their need satisfying experiences in exercise contexts. Each item is worded to reflect higher degrees of psychological need satisfaction for competence, autonomy, and relatedness.

If you have any questions, please feel free to ask them. You also have the right to withdraw from this study at any time without consequence by informing the principal investigator (Phil Wilson). To ensure confidentiality, a code number has been placed at the top of your rating form. Only the principal investigator will have access to the names of individuals corresponding to the codes.

Thank you for your participation.

Phil Wilson

Directions for experts completing the ICRF

Please rate the degree to which you feel ***each item matches*** the content descriptions (see below) defining each psychological need satisfaction construct. Also, feel free to make any additional comments in the space provided about the relevance of the item to exercise participants or the meaning interpreted from the wording of each item. These comments will be used to refine and improve the initial item pool.

When you have rated all the items and provided any additional comments you feel necessary, please return the completed ICRF via email, fax, or mail. If you are completing this form electronically, the best way to do this is to save this attachment as a Word document. Then, open the attachment in Word and complete the form. The file is set up as a "locked" file. To provide responses on the Likert scale, simply double click the appropriate box with your mouse arrow. A dialogue box will appear and you can indicate that you wish to check of the relevant box in the default option. An "X" should then appear in the shaded box. Additional comments can be added in the box located beneath each rating table. Once you have finished completing the form, save your document and email it back to pmwilson@ualberta.ca as an attached file.

Description of Content Areas

Competence: These items are intended to capture whether the participant perceives that they are capable of performing or completing challenging exercises effectively.

Autonomy: These items are intended to capture whether the participant perceives that the exercises they do reflect their own choices and values, and are undertaken volitionally without external coercion.

Relatedness: These items are intended to capture whether the participant perceives they are meaningfully connected with other people in the social environment while they are exercising.

Description of rating scale anchors:

*Please indicate the degree to which you feel **each** item listed below matches **each** of the three content areas defined above on the scale provided. Please feel free to add any additional comments where necessary.*

Example

The following box contains an example of how to complete the ICRF.

Survey item: I think I am pretty good at exercise

Content area	Poor Match	Fair Match	Good Match	Very Good Match	Excellent Match
Competence	☐	☐	☐	☐	☒
Autonomy	☒	☐	☐	☐	☐
Relatedness	☒	☐	☐	☐	☐

Comments:

The item seems to be asking about how “good” I am at exercise, not if I associate with others or feel it is my choice to do the activity.

Participants will be given the following instructions that include an operational definition of exercise **from which to base their responses to each survey item:**

Instructions

The following questions pertain to your thoughts and feelings about exercise. **Exercise refers to "planned, structured, bodily movements done with the specific intention of improving or maintaining one or more components of physical fitness such as muscular strength, endurance, body composition, or flexibility (Casperson, Powell, & Christenson, 1985)."** Please keep this "definition" of exercise in mind as you respond to the following questions. There are no right or wrong answers to these questions and it is YOUR experiences that we are particularly interested in.

Participants will respond to each item on a 6-point Likert scale anchored at the extremes by (1) False and (6) True.

Item 1: I feel connected to people with similar exercise goals when I workout

Content area	Poor Match	Fair Match	Good Match	Very Good Match	Excellent Match
Competence	☐	☐	☐	☐	☐
Autonomy	☐	☐	☐	☐	☐
Relatedness	☐	☐	☐	☐	☐

Comments:

Item 2: I am personally responsible for the exercise that I do

Content area	Poor Match	Fair Match	Good Match	Very Good Match	Excellent Match
Competence	☐	☐	☐	☐	☐
Autonomy	☐	☐	☐	☐	☐
Relatedness	☐	☐	☐	☐	☐

Comments:

Item 3: I personally initiate the exercise that I do

Content area	Poor Match	Fair Match	Good Match	Very Good Match	Excellent Match
Competence	☐	☐	☐	☐	☐
Autonomy	☐	☐	☐	☐	☐
Relatedness	☐	☐	☐	☐	☐

Comments:

Item 4: I feel competent in my ability to successfully complete each exercise

Content area	Poor Match	Fair Match	Good Match	Very Good Match	Excellent Match
Competence	☐	☐	☐	☐	☐
Autonomy	☐	☐	☐	☐	☐
Relatedness	☐	☐	☐	☐	☐

Comments:

Item 5: I feel involved with other people when I exercise

Content area	Poor Match	Fair Match	Good Match	Very Good Match	Excellent Match
Competence	☐	☐	☐	☐	☐
Autonomy	☐	☐	☐	☐	☐
Relatedness	☐	☐	☐	☐	☐

Comments:

Item 6: I feel related to other people when I exercise

Content area	Poor Match	Fair Match	Good Match	Very Good Match	Excellent Match
Competence	☐	☐	☐	☐	☐
Autonomy	☐	☐	☐	☐	☐
Relatedness	☐	☐	☐	☐	☐

Comments:

Item 7: I choose the exercises that I do

Content area	Poor Match	Fair Match	Good Match	Very Good Match	Excellent Match
Competence	☐	☐	☐	☐	☐
Autonomy	☐	☐	☐	☐	☐
Relatedness	☐	☐	☐	☐	☐

Comments:

Item 8: I feel capable of completing the exercises in my workout

Content area	Poor Match	Fair Match	Good Match	Very Good Match	Excellent Match
Competence	☐	☐	☐	☐	☐
Autonomy	☐	☐	☐	☐	☐
Relatedness	☐	☐	☐	☐	☐

Comments:

Item 9: I feel affiliated to other people when I exercise

Content area	Poor Match	Fair Match	Good Match	Very Good Match	Excellent Match
Competence	☐	☐	☐	☐	☐
Autonomy	☐	☐	☐	☐	☐
Relatedness	☐	☐	☐	☐	☐

Comments:

Item 10: I feel capable of completing challenging exercises

Content area	Poor Match	Fair Match	Good Match	Very Good Match	Excellent Match
Competence	☐	☐	☐	☐	☐
Autonomy	☐	☐	☐	☐	☐
Relatedness	☐	☐	☐	☐	☐

Comments:

Item 11: I am able to complete difficult exercises

Content area	Poor Match	Fair Match	Good Match	Very Good Match	Excellent Match
Competence	☐	☐	☐	☐	☐
Autonomy	☐	☐	☐	☐	☐
Relatedness	☐	☐	☐	☐	☐

Comments:

Item 12: I feel that I have a say in the exercises that I do

Content area	Poor Match	Fair Match	Good Match	Very Good Match	Excellent Match
Competence	☐	☐	☐	☐	☐
Autonomy	☐	☐	☐	☐	☐
Relatedness	☐	☐	☐	☐	☐

Comments:

Item 13: I feel supported by people who are important to me when I exercise

Content area	Poor Match	Fair Match	Good Match	Very Good Match	Excellent Match
Competence	☐	☐	☐	☐	☐
Autonomy	☐	☐	☐	☐	☐
Relatedness	☐	☐	☐	☐	☐

Comments:

Item 14: I feel autonomous in the exercises that I do

Content area	Poor Match	Fair Match	Good Match	Very Good Match	Excellent Match
Competence	☐	☐	☐	☐	☐
Autonomy	☐	☐	☐	☐	☐
Relatedness	☐	☐	☐	☐	☐

Comments:

Item 15: I feel that the exercises I do reflect my personal choices

Content area	Poor Match	Fair Match	Good Match	Very Good Match	Excellent Match
Competence	☐	☐	☐	☐	☐
Autonomy	☐	☐	☐	☐	☐
Relatedness	☐	☐	☐	☐	☐

Comments:

Item 16: I pick the exercises that I want to do

Content area	Poor Match	Fair Match	Good Match	Very Good Match	Excellent Match
Competence	☐	☐	☐	☐	☐
Autonomy	☐	☐	☐	☐	☐
Relatedness	☐	☐	☐	☐	☐

Comments:

Item 17: I feel that exercise is something I do willingly

Content area	Poor Match	Fair Match	Good Match	Very Good Match	Excellent Match
Competence	☐	☐	☐	☐	☐
Autonomy	☐	☐	☐	☐	☐
Relatedness	☐	☐	☐	☐	☐

Comments:

Item 18: I am able to perform each exercise correctly

Content area	Poor Match	Fair Match	Good Match	Very Good Match	Excellent Match
Competence	☐	☐	☐	☐	☐
Autonomy	☐	☐	☐	☐	☐
Relatedness	☐	☐	☐	☐	☐

Comments:

Item 19: I feel a sense of attachment to others when I exercise

Content area	Poor Match	Fair Match	Good Match	Very Good Match	Excellent Match
Competence	☐	☐	☐	☐	☐
Autonomy	☐	☐	☐	☐	☐
Relatedness	☐	☐	☐	☐	☐

Comments:

Item 20: I feel free to exercise my own way

Content area	Poor Match	Fair Match	Good Match	Very Good Match	Excellent Match
Competence	☐	☐	☐	☐	☐
Autonomy	☐	☐	☐	☐	☐
Relatedness	☐	☐	☐	☐	☐

Comments:

Item 21: I feel competent in the exercises I attempt

Content area	Poor Match	Fair Match	Good Match	Very Good Match	Excellent Match
Competence	☐	☐	☐	☐	☐
Autonomy	☐	☐	☐	☐	☐
Relatedness	☐	☐	☐	☐	☐

Comments:

Item 22: I feel included by other people when I exercise

Content area	Poor Match	Fair Match	Good Match	Very Good Match	Excellent Match
Competence	☐	☐	☐	☐	☐
Autonomy	☐	☐	☐	☐	☐
Relatedness	☐	☐	☐	☐	☐

Comments:

Content Relevance Form (CRF)

I would now like to get your ***OVERALL*** *impression of the items that have been included in the initial item pool to measure perceived competence, autonomy, and relatedness within the exercise context.*

1. How well do you feel all of the items included in the initial item pool represent the constructs of competence, autonomy, and relatedness?

	Poor Representation	Fair Representation	Good Representation	Very Good Representation	Excellent Representation
Competence items	☐	☐	☐	☐	☐
Autonomy items	☐	☐	☐	☐	☐
Relatedness items	☐	☐	☐	☐	☐

2. Do you think the items are appropriate for use with people in exercise contexts in terms of the degree to which they represent the constructs of competence, autonomy, and relatedness?

	Not at All	Not really	Somewhat	Yes	Yes, absolutely
Competence items	☐	☐	☐	☐	☐
Autonomy items	☐	☐	☐	☐	☐
Relatedness items	☐	☐	☐	☐	☐

3. Are there any additional items that you feel should be included to represent perceived competence, autonomy, or relatedness?

Yes ☐ *No* ☐

If yes, please indicate what these items are in the space provided:

4. Are there any items in the initial item pool that you feel measure more than competence, autonomy, or relatedness?

Yes ☐ *No* ☐

If yes, please indicate what these items are and why you feel this way in the space provided:

Appendix D

Psychological Need Satisfaction in Exercise Scale

The following statements represent different experiences people feel when they are exercising. Please indicate on the scale provided the degree to which YOU TYPICALLY have these experiences while you are exercising.

	False	Mostly False	More false than true	More true than false	Mostly True	True
I feel that I am able to complete exercises that are personally challenging	1	2	3	4	5	6
I feel attached to my exercise companions because they accept me for who I am	1	2	3	4	5	6
I feel like I share a common bond with people who are important to me when we exercise together	1	2	3	4	5	6
I feel connected to my exercise companions because they understand my point of view	1	2	3	4	5	6
I feel confident I can do even the most challenging exercises	1	2	3	4	5	6
I feel socially connected to my exercise companions	1	2	3	4	5	6
I feel a sense of camaraderie with my exercise companions because we exercise for the same reasons	1	2	3	4	5	6
I feel free to exercise in a way that suits me	1	2	3	4	5	6
I feel confident in my ability to perform exercises that personally challenge me	1	2	3	4	5	6
I feel close to my exercise companions who appreciate how difficult exercise can be	1	2	3	4	5	6
I feel comfortable being myself when I talk with my exercise companions	1	2	3	4	5	6
I feel free to exercise in my own way	1	2	3	4	5	6
I feel free to make my own exercise program decisions	1	2	3	4	5	6
I feel capable of completing exercises that are challenging to me	1	2	3	4	5	6
I feel like I am in charge of my exercise program decisions	1	2	3	4	5	6
I feel like I am capable of doing even the most challenging exercises	1	2	3	4	5	6
I feel like I have a say in choosing the exercises that I do	1	2	3	4	5	6
I feel connected to the people who I interact with while we exercise together	1	2	3	4	5	6
I feel like exercise is something that I want to do	1	2	3	4	5	6
I feel good about the way I am able to complete challenging exercises	1	2	3	4	5	6
I feel like I get along well with other people who I interact with while we exercise together	1	2	3	4	5	6
I feel free to choose which exercises I participate in	1	2	3	4	5	6
I feel that the exercises I do reflect my own personal choices	1	2	3	4	5	6
I feel like I am the one who decides what exercises I do	1	2	3	4	5	6

Motivation for Physical Activity Measure Revised – Social Motives Subscale

The following is a list of reasons why people exercise. *Keeping in mind your primary exercise activity*, please indicate how true each reason is for *YOU* on the scale provided.

I exercise because…	Not at all true						Very true
…I want to be with my friends	1	2	3	4	5	6	7
…I like to be with others who are interested in this activity	1	2	3	4	5	6	7
…I want to meet new people	1	2	3	4	5	6	7
…my friends want me to	1	2	3	4	5	6	7

Intrinsic Motivation Inventory – Perceived Competence Subscale

The following statements concern *YOUR thoughts* about exercise. Please circle the number that indicates how strongly you agree or disagree with each of the following statements.

	Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree
I think I do pretty well at exercise compared to others	1	2	3	4	5	6	7
I am satisfied with my exercise performance	1	2	3	4	5	6	7
Exercise is an activity that I couldn't do very well	1	2	3	4	5	6	7
After exercising for a while, I felt pretty competent	1	2	3	4	5	6	7
I think I am pretty good at exercise	1	2	3	4	5	6	7
I am pretty skilled at exercise	1	2	3	4	5	6	7

Locus of Causality for Exercise Scale

	Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree
Exercising is not something I would necessarily choose to do, rather it is something that I feel I ought to do	1	2	3	4	5	6	7
Having to exercise is a bit of a bind but it has to be done	1	2	3	4	5	6	7
I exercise because I like to rather than because I feel I have t	1	2	3	4	5	6	7

Intrinsic Motivation Inventory – Perceived Choice Subscale

The following statements concern *YOUR thoughts* about exercise. Please circle the number that indicates how strongly you agree or disagree with each of the following statements.

	Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree
I exercise because I have to	1	2	3	4	5	6	7
I believe I have some choice about doing exercise	1	2	3	4	5	6	7
I exercise because I have no choice	1	2	3	4	5	6	7
I don't really have a choice about doing exercise	1	2	3	4	5	6	7
I feel like I have to exercise	1	2	3	4	5	6	7
I feel like it is not my own choice to exercise	1	2	3	4	5	6	7
I exercise because I want to	1	2	3	4	5	6	7

Exercise Motivation Inventory 2 – Affiliation Subscale

The following statements concern reasons people often give when asked why they are currently exercising or why they would choose to exercise. Please circle the appropriate number that indicates how true each statement is for you.

Personally, I exercise (or might exercise)…	Not at all true for me					Very true for me
…To spend time with friends	0	1	2	3	4	5
…To enjoy to the social aspects of exercising	0	1	2	3	4	5
…To have fun being active with other people	0	1	2	3	4	5
…To make new friends	0	1	2	3	4	5

Behavioral Regulation in Exercise Questionnaire

Why do you exercise? The following list identifies reasons why people exercise. Please indicate on the scale provided how true each statement is for YOU with (0) = Not true for me and (4) = Very true for me.

	Not true for me	Sometimes true for me	Moderately true for me	Often true for me	Very true for me
I get restless if I don't exercise regularly	0	1	2	3	4
I think it is important to make the effort to exercise regularly	0	1	2	3	4
I find exercise a pleasurable activity	0	1	2	3	4
It's important to me to exercise regularly	0	1	2	3	4
I get pleasure and satisfaction from participating in exercise	0	1	2	3	4
I feel under pressure from my friends/family to exercise	0	1	2	3	4
I exercise because it's fun	0	1	2	3	4
I exercise because other people say I should	0	1	2	3	4
I feel ashamed when I miss an exercise session	0	1	2	3	4
I exercise because others will not be pleased with me if I don't	0	1	2	3	4
I enjoy my exercise sessions	0	1	2	3	4
I feel guilty when I don't exercise	0	1	2	3	4
I take part in exercise because my friends/family/spouse say I should	0	1	2	3	4
I value the benefits of exercise	0	1	2	3	4
I feel like a failure when I haven't exercised in a while	0	1	2	3	4

Instrumental Attitudes Towards Exercise Scale

The following statements represent attitudes different people have about exercise. Please circle the number that best represents how you feel about exercise…

For me, exercising regularly is...

Foolish	1	2	3	4	5	6	7	8	9	Wise
Useless	1	2	3	4	5	6	7	8	9	Useful
Harmful	1	2	3	4	5	6	7	8	9	Beneficial

Negative Affect Items (Positive Affect Negative Affect Schedule – Short Form)

This scale contains a number of words describing different feelings and emotions. Indicate to what extent **YOU** generally feel this way when **YOU** exercise. That is, how **YOU FEEL** on the average when **YOU** exercise.

	Very Slightly or not at all	A Little	Moderately	Quite a bit	Extremely
Afraid	1	2	3	4	5
Upset	1	2	3	4	5
Nervous	1	2	3	4	5
Scared	1	2	3	4	5
Distressed	1	2	3	4	5

Appendix B

Test Administration Instructions

The following instructions were used to "guide" the data collection phase for each test administration throughout this dissertation.

"Good morning/evening. My name is Phil and I am a graduate student in the Faculty of Physical Education and Recreation collecting information about people's exercise experiences. You are being asked to participate in a study about peoples' thoughts and feelings during exercise and about the reasons why they participate in exercise. I am conducting this study to develop a questionnaire that allows me to understand some of the experiences people have while they are participating in exercise. I believe that this will help me gain a greater understanding of the reasons why some people continue to exercise while others terminate their involvement. I do ask that if you choose to participate, you complete a series of questions that will take approximately 10 minutes of your time. Your participation is voluntary and all of the information that you provide will remain confidential. Should you choose to participate, please read the information letter and sign the informed consent page associated with it. The information letter is for your personal records, but please return the signed consent letters with the surveys at the end of this session. Remember that this is a voluntary activity and you are free to withdraw or not participate at any point in time simply by informing me of your decision. If you have any questions please ask. For those who choose to participate, a box is located next to the door for you to return your completed questionnaire on your way out of the room. Thank you for your help with this project."